University of Alberta
Printing Department

Digitized by the Internet Archive
in 2019 with funding from
University of Alberta Libraries

https://archive.org/details/studyofrelations00lach

Thesis
M.S
#8

THE UNIVERSITY OF ALBERTA

A STUDY OF THE RELATIONSHIP BETWEEN ABILITY GROUPING AND THE ACHIEVEMENT OF GRADE NINE PUPILS FROM 1956 TO 1964

by

LACHLAN MACLEAN CAMPBELL

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF EDUCATION

DEPARTMENT OF EDUCATIONAL ADMINISTRATION

EDMONTON, ALBERTA

MARCH, 1965

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "A Study of the Relationship Between Ability Grouping and the Achievement of Grade Nine Pupils From 1956 to 1964" submitted by Lachlan Maclean Campbell in partial fulfilment of the requirements for the degree of Master of Education.

ABSTRACT

The main purpose of this study was to determine the relationship between three forms of grouping--heterogeneous, homogeneous and subject--and the achievement of grade nine Parkview school students at three ability levels on the provincial Grade IX final examinations. The study was confined to Parkview grade nine students over an eight-year period from September, 1956 to June, 1964.

The study actually consisted of two parts. The first compared achievement at three ability levels in the six departmental subjects during a three-year period of heterogeneous grouping with that during the next three-year period of homogeneous grouping. The second studied the relationship at three ability levels between achievement in language, mathematics and science and the three methods of grouping, subject grouping being carried out in the three subjects during the final two years.

The data consisted of all Parkview grade nine departmental stanine scores for the eight-year period. Two parallel analyses were carried out. The first was based on thirty-two matched pairs for each of three ability levels and selected from each of the three periods of grouping. Pairs were matched on the basis of sex, chronological age, attendance, SCAT percentile and Laycock I.Q. The second was based on a similar number of cases chosen randomly but with a wider ability range for level two.

The analysis of variance: three-way classification was followed

by analysis of variance: two-way classification and then by the appropriate t-tests.

The analysis of pupil achievement comparing heterogeneous and homogeneous grouping provided some evidence in favor of the latter. In social studies, language, mathematics and science, all significant differences (.05 and better) and all differences in means supported this inference and suggested that, in general, there may be certain advantages deriving from homogeneous grouping in these subjects. There were no significant differences in reading or in literature.

The general inference that subject grouping would produce higher academic achievement was not borne out in this study. For language there was some statistical evidence and a general tendency supporting the superiority of subject grouping over homogeneous. In mathematics there were no significant differences between these two methods. No general tendency was evident. In science the general tendency would appear to favor homogeneous over subject grouping.

All conclusions and inferences relate only to grade nine classes in Parkview school, although they may be extended on a judgmental basis to the same grade level in schools with similar characteristics.

The complexity of the problem and the number of variables--teacher qualifications, length and type of experience, class size, motivation, and the variability in general and specific abilities of the student population from year to year--tend to make all conclusions tentative.

The principal recommendations were that for this particular school there would appear to be sufficient evidence to warrant the utilization of

homogeneous grouping in social studies, language, mathematics and science and that, if timetabling permitted and achievement was low, subject grouping in one subject (here language) would be more effective than homogeneous grouping in improving examination results.

ACKNOWLEDGEMENTS

The writer is indebted to the teachers of Parkview Junior High school for their cooperation in carrying out such a long study.

The Chairman of the thesis committee, Dr. William D. Knill, was always accessible and willingly gave guidance and encouragement. The assistance received from Dr. W. B. Dockrell and Dr. Erwin Miklos has been much appreciated.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	THE PROBLEM	1
	The Significance of the Problem	1
	Purposes of the Study	7
	Main Purpose	7
	Sub-Purposes	7
	Delimitations	9
	Limitations	9
	Definition of Terms	10
	Heterogeneous Grouping	10
	Homogeneous Grouping	10
	Subject Grouping	11
	Academic Achievement	11
	Assumptions	12
	Summary	13
II.	RELATED LITERATURE AND RESEARCH	14
	Review of the Literature	14
	Related Research	27
	Summary	30
III.	DESIGN OF THE STUDY	32
	Sources of Data	32
	The Population	32
	Organization of the Population	33

CHAPTER PAGE

Heterogeneous Grouping 33
Homogeneous Grouping 34
Subject Grouping 34
Matched Pairs 34
Random Sample 35
Related Factors 36
Methods of Analysis 39
Experimental Model 39
Analysis of Variance: Three-Way Classification 41
Error Term 43
Analysis of Variance: Two-Way Classification 43
t-Tests 44
Assumptions Underlying the Analysis of Variance 45
Treatment of the Data 47
IV. ANALYSIS OF THE DATA 49
Analysis of Variance: Heterogeneous/Homogeneous Grouping . . . 49
Analysis of Variance: Two-Way Classification 52
Analysis of Variance: Reading 52
Analysis of Variance: Literature 52
Analysis of Variance: Social Studies 54
Analysis of Variance: Language 58
Analysis of Variance: Science 58
Summary of Analysis: 2 x 3 x 6 62

CHAPTER PAGE

Analysis of Variance: Heterogeneous/Homogeneous/Subject Grouping 63
Analysis of Variance: Three-Way Classification--3 x 3 x 3 . 64
Analysis of Variance: Two-Way Classification 64
Language 65
Mathematics 69
Science 72
Summary of Analysis: 3 x 3 x 3 75
V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 80
Summary of the Findings 80
Ability Levels 80
Methods of Grouping 80
Some Conclusions and Implications 84
Recommendations 86
Recommendations for Future Study 88
BIBLIOGRAPHY 91
APPENDICES 96

LIST OF TABLES

TABLE PAGE

I. Parkview Grade Nine Class Organization Over the Eight-Year Period 1956 to 1964 33

II. Organization of Population for Matched Pairs and Random Sampling 36

III. Means of Selected Characteristics for Matched Pairs and Random Samples 37

IV. Academic and Professional Education of Parkview Grade Teachers in Years 38

V. Teaching Experience of Parkview Grade Nine Teachers in Years . 38

VI. Summary of Tests of the Normality of Distributions for Matched Pairs and Random Data 46

VII. Summary of Tests for Homogeneity of Error Variance Through Use of the F_{max} Statistic 46

VIII. Summary of Analysis of Variance for Data of Appendix B, Table XLVIII Heterogeneous/Homogeneous--2x3x6 (Matched) . . 50

IX. Summary of Analysis of Variance for Data of Appendix B, Table XLIX, Heterogeneous/Homogeneous--2x3x6 (Random) . . . 51

X. Summary of Analysis of Variance: Reading (Matched) Heterogeneous/Homogeneous--2x3 53

XI. Summary of Analysis of Variance: Reading (Random) Heterogeneous/Homogeneous--2x3 53

XII. Summary of Analysis of Variance: Literature (Matched) Heterogeneous/Homogeneous--2x3 54

TABLE PAGE

XIII. Summary of Analysis of Variance: Literature (Random) Heterogeneous/Homogeneous--2x3 55

XIV. Summary of Analysis of Variance: Social Studies (Matched) Heterogeneous/Homogeneous--2x3 55

XV. Summary of Analysis of Variance: Social Studies (Random) Heterogeneous/Homogeneous--2x3 56

XVI. Summary of Analysis of Variance: Language (Matched) Heterogeneous/Homogeneous--2x3 57

XVII. Summary of Analysis of Variance: Language (Random) Heterogeneous/Homogeneous--2x3 57

XVIII. Summary of Analysis of Variance: Mathematics (Matched) Heterogeneous/Homogeneous--2x3 59

XIX. Summary of Analysis of Variance: Mathematics (Random) Heterogeneous/Homogeneous--2x3 59

XX. Summary of Analysis of Variance: Science (Matched) Heterogeneous/Homogeneous--2x3 60

XXI. Summary of Analysis of Variance: Science (Random) Heterogeneous/Homogeneous--2x3 60

XXII. Summary of Significance of the Difference Between Two Means For Correlated Samples (Matched Pairs) 61

XXIII. Summary of Significance of the Difference Between Two Means For Independent Samples (Random Data) 61

XXIV. Summary of Analysis of Data: Heterogeneous/Homogeneous--2x3x6 65

TABLE PAGE

XXV. Summary of Analysis of Variance for Data of Appendix C Table L, Matched Pairs: 3x3x3 65

XXVI. Summary of Analysis of Variance for Data of Appendix C, Table LI, Random: 3x3x3 66

XXVII. Summary of Analysis of Variance: Language (Matched) Heterogeneous/Homogeneous/Subject Grouping--3x3 67

XXVIII. Summary of Analysis of Variance: Language (Random) Heterogeneous/Homogeneous/Subject Grouping--3x3 67

XXIX. Summary of Analysis of Variance: Language (Matched) Homogeneous/Subject Grouping--2x3 68

XXX. Summary of Analysis of Variance: Language (Random) Homogeneous/Subject Grouping--2x3 68

XXXI. Summary of Analysis of Variance: Mathematics (Matched) Heterogeneous/Homogeneous/Subject Grouping--3x3 70

XXXII. Summary of Analysis of Variance: Mathematics (Random) Heterogeneous/Homogeneous/Subject Grouping--3x3 70

XXXIII. Summary of Analysis of Variance: Mathematics (Matched) Homogeneous/Subject Grouping--2x3 71

XXXIV. Summary of Analysis of Variance: Mathematics (Random) Homogeneous/Subject Grouping--2x3 71

XXXV. Summary of Analysis of Variance: Science (Matched) Heterogeneous/Homogeneous/Subject Grouping--3x3 73

XXXVI. Summary of Analysis of Variance: Science (Random) Heterogeneous/Homogeneous/Subject Grouping--3x3 73

TABLE PAGE

XXXVII. Summary of Analysis of Variance: Science (Matched) Homogeneous/Subject Grouping--2x3 74

XXXVIII. Summary of Analysis of Variance: Science (Random) Homogeneous/Subject Grouping--2x3 74

XXXIX. Summary of Significance of the Difference Between Two Means For Correlated Samples (Matched Pairs) 76

XL. Summary of Significance of the Difference Between Two Means for Independent Samples (Random Data) 77

XLI. Summary of Analysis of Data: Heterogeneous/Homogeneous/ Subject Grouping 79

XLII. Stanine Achievement of Parkview Grade Nine Students: Matched Pairs--Level One 98

XLIII. Stanine Achievement of Parkview Grade Nine Students: Matched Pairs--Level Two 99

XLIV. Stanine Achievement of Parkview Grade Nine Students: Matched Pairs--Level Three 100

XLV. Stanine Achievement of Parkview Grade Nine Students: Random Data--Level One 101

XLVI. Stanine Achievement of Parkview Grade Nine Students: Random Data--Level Two 102

XLVII. Stanine Achievement of Parkview Grade Nine Students: Random Data--Level Three 103

XLVIII. Computation for Analysis of Variance: 2x3x6 (Matched Pairs) 105

XLIX. Computation for Analysis of Variance: 2x3x6 (Random Data) . 107

TABLE PAGE

L. Computation for Analysis of Variance: 3x3x3 (Matched Pairs) 110

LI. Computation for Analysis of Variance: 3x3x3 (Random Data) . 112

LII. Summary of Stanine Achievement Means 115

CHAPTER I

THE PROBLEM

I. THE SIGNIFICANCE OF THE PROBLEM

One of the problems facing teachers generally is the difficulty of providing within the classroom for the educational needs of students ranging in ability from gifted to slow. The extent of the problem has been indicated by Cook and Clymer reporting on acceleration and retardation:

> The typical range of ability in any grade (disregarding 2% of the pupils at each end of the distribution) is equal to two-thirds of the chronological age of the median pupil in that grade. . . . When the achievement in the various subjects is measured at each grade level, the range of achievement is found to be approximately the same as that for intelligence described above.[1]

Administrators and teachers searching for ways of meeting this difficulty have continued to look carefully at ability grouping as a possible solution. The rationale underlying homogeneous or ability grouping, very briefly, suggests that it is possible to select students in a narrow achievement range in a given curriculum area, thus permitting the teacher to use mass teaching procedures which will ultimately widen the range of student achievement. As a result the teacher will be able to help the group more effectively than he could if all levels of achievement were present.

While it is generally accepted that homogeneous grouping reduces

---

[1]W. W. Cook and T. Clymer, "Acceleration and Retardation," National Society for the Study of Education Yearbook, 1961, Part I (Chicago: University of Chicago Press, 1962), 179-208.

heterogeneity in individual subjects by only 20 per cent of the original range, it is argued that this reduction is worthwhile. It is generally agreed, however, that subject grouping, a refinement of homogeneous grouping, can reduce heterogeneity in a subject to a much greater extent.

The problem has been studied extensively over the past forty years in several countries throughout the world. In general, research on the subject has been inconclusive. Locally, interest has been evidenced through the recent large-scale Edmonton study[2] at the grade seven and eight level.

R. L. Godwin,[3] at the Leadership Course for School Principals in Edmonton, 1962, questioned the use of most American studies of ability grouping for consideration in the Canadian context. American school systems use smaller classes than are found in many parts of Canada (usually not more than twenty or twenty-five students to a teacher); semester programming is widespread and the curricula differ. Most of their experiments ignore the all-important teacher variable. Weak sampling procedures, poorly matched groups, inadequate testing instruments, or too little data often raise doubts as to the validity of their conclusions.

Her assessment of related research led her to conclude that:

> . . .the variability of youth is so great that, in the senior high school at least, some form of grouping is recommended; that

---

[2]W. B. Dockrell, "Edmonton Junior High School Streaming Project," Committee Report (Edmonton: Division of Educational Psychology, University of Alberta, 1961), pp. 1,2 (mimeographed).

[3]Ruth Godwin, "Improving Instructional Procedures to Meet Individual Differences in the Senior High School," The Alberta School Principal, 1962 (Edmonton: University of Alberta Press, 1962), p. 71.

> grouping seems to assist most senior high school students when the teacher is sufficiently skilled at working with the types of students he has been assigned and if the instructional materials have been varied to fit the specific needs of the particular subject being taught; and that teachers need assistance in discovering ways and means of developing, fostering and encouraging individual differences.[4]

Godwin's comments on differences between American and Canadian school systems, added to the limitations suggested by the several reviews indicate the need for further grouping study in the local context. General recognition of the importance of the question adds further support for study at the grade nine level.

Luvern L. Cunningham,[5] at the same Leadership Course, pointed out the influence of the "Hawthorne effect" on various innovations of change. It may be that many studies of short duration must be disregarded because of the "halo" effect. The present study, by reason of its length, may be able to avoid this bias.

Alberta Composite High School Teachers seem to think that they would be better teachers if they taught students grouped according to ability. I. E. Housego and G. L. Mowat, reporting on a study of gifted youth noted that:

> Teachers believed that ability grouping would increase opportunities to enrich programmes for the gifted. They contended that present efforts are hampered by heterogeneous classes, by large classes and by lack of time to plan for and to teach the gifted.[6]

---

[4] Ibid., p. 74.

[5] Luvern L. Cunningham, "Effecting Organizational Change, The Alberta School Principal, 1962 (Edmonton: University of Alberta Press, 1962), p. 124.

[6] I. E. Housego and G. L. Mowat, "Alberta Composite High Schools and Gifted Youth," The Alberta Journal of Educational Research (March, 1959), p. 124.

Some grade nine teachers hold views similar to those of high school teachers in regard to the advantages of ability grouping. Teachers holding such views achieve job satisfaction when classes are grouped according to ability. Staff morale may be raised and educational goals may be more closely attained. It would seem that staff acceptance of the possibility that ability grouping may facilitate the teaching and learning situation is necessary for maximum teacher effort and efficiency.

There is no question that effective teaching requires the adoption of methods and techniques to meet group and individual differences. Any study attempting to determine the form of grouping most advantageous for pupil achievement under present teachers should include such adaptation as an integral part of the investigation. The point under dispute is not whether grouping, per se, is advantageous, but rather whether or not grouping as a form of organization facilitates the adaptation of methods, materials and techniques which results in higher achievement and whether or not grouping, in its subtle effects on pupil personnel and teaching staff, tends to have a positive effect on academic achievement as measured by grade nine departmental examinations.

Educators seem to be in agreement on suggesting a modified curriculum for the low group and enrichment for the gifted. This, of course, raises certain problems where experimental study is concerned. For this purpose one must presume that the low group covers a basic minimum of any course and that enrichment for the upper group is related to the course content. The measuring instrument to be valid must encompass these upper and lower limits. This raises the question as to whether any commercial

standardized test can serve as a valid measure of gain in achievement.

With regard to this Ekstrom stated:

> Several studies of gifted children were confounded in that the standardized tests used were not suited to the group. Because of their special ability, the students scored well beyond the level where the tests were appropriate measures. It has also been observed that classes for the gifted are enriched with many additional subjects. Most standardized tests do not measure achievement in these subjects.[7]

More recently Enns commented:

> Further implementation of some of the diversified instructional procedures. . .will force us to modify the use of examinations. Already we are running into serious difficulties in testing streamed or 'homogeneously' grouped classes.[8]

If we assume that the departmental examinations are a valid and reliable measure of the educational objectives of the grade nine curriculum in Alberta, then their use may provide a better comparison of achievement under different forms of grouping than those used in related studies.

The basis for grouping has been questioned in many studies. That it should be a valid measure of achievement in the local curriculum seems sound. This would preclude the use of I.Q. alone. It would preclude, too, the use of some standardized test batteries which do not meet the requirement on the overall basis or in some of their parts.

One practical basis for grouping is the final subject achievement mark assigned at the end of the school year. This commonly comprises two or more mid-term tests together with a final comprehensive examination. At the junior high level all students in a grade may write the

---

[7]R. B. Ekstrom, "Experimental Studies of Homogeneous Grouping: A Critical Review," School Review, 29 (Summer, 1961), p. 220.

[8]F. Enns, "Assessing the Effects of Change," The Alberta School Principal, 1962 (Edmonton: University of Alberta Press, 1962), p. 168.

same measuring instruments, facilitating the rank ordering of subject achievement. Subject marks can be equated by conversion to T-scores or by scaling to the curve of the school's previous grade nine achievement. A more reliable measure perhaps would be the utilization of city or district-wide tests with local norms for each subject.

Findings of the recent Edmonton grouping study involving three thousand grade seven and eight pupils indicated differences in effect for small and large junior high schools. Certain inherent factors may have been responsible for the difference. Group pressure to conform in high schools is extremely powerful and if the accepted values of the group downgrade the intellectual and enthrone the athlete, the effect on academic achievement can be negative. Such pressure may not be so apparent in smaller junior high schools.

Classes in smaller junior high schools differ in academic aptitude from those in larger ones. For example, the low homogeneous class in a three-room junior high grade will contain the bottom third of the students, while in an eight-room grade it will contain the bottom eighth of the students. The mean mental aptitude of the latter will be lower and the range of the group will be narrower. The greater range of the low group in the small junior high tends to ensure more active response, so that teacher acceptance is not the problem it may be in the large school. Worth[9] referred to the assignment of two or more achievement groups at the elementary level to provide "sparkle" in each classroom.

---

[9]W. H. Worth, "Proposals for Improved Organization of the Elementary School, "The Alberta School Principal, 1962 (Edmonton: University of Alberta Press, 1962), p. 59.

Students at the grade nine level are certainly more mature than those at the grade seven level. Locally, they face the prospect of independent provincial examinations. Their stanine achievement is to be used to determine the high school pattern they are permitted to choose. The difference in motivation may have some influence on the effectiveness of grouping at these two grade levels.

Great differences exist in the ability levels of various schools. High socio-economic areas tend to have fewer students in the low-ability range and more in the high-ability range than low socio-economic areas. Motivation and interest in academic subjects vary. It may be that homogeneous grouping will prove beneficial in one area and not in another, in a high ability area and not in a lower area.

This study attempted to determine the relationship between ability grouping and the achievement of Parkview grade nine pupils as measured by departmental examinations. It is recognized that many other factors were probably involved--some uncontrolable, as for example: class size, teacher qualifications and experience. Some of these were noted and their possible effects indicated.

II. PURPOSES OF THE STUDY

Main Purpose

It was the purpose of this investigation to study the relationship between three forms of grouping and the achievement of grade nine Parkview school pupils on the provincial final examinations over an eight-year period from September, 1956 to June, 1964.

The organization of Parkview grade nine class groups over this

period is illustrated in Table I, page 33. The first three-year period involved heterogeneous grouping; the second three-year period homogeneous grouping; and the last two-year period, subject grouping in language, mathematics and science.

Sub-Purposes

A. To test the hypothesis that homogeneous grouping on the basis of the sum of achievement in grade eight academic subjects bears no relationship to the achievement of Parkview students on the grade nine departmental examinations in reading, literature, social studies, language, mathematics and science.

B. To test the hypothesis that subject grouping in language, mathematics and science, on the basis of grade eight achievement in each of these subjects bears no relationship to the achievement of Parkview students on the grade nine departmental examinations in these subjects.

III. DELIMITATIONS

The limitations for this study have been set as follows:

A. This study was restricted to the school years 1956 - 1964.

B. This study was restricted to grade nine, Parkview school.

C. Only subjects on which Departmental Final Examinations are written were considered in this study.

IV. LIMITATIONS

A. The study was concerned only with Parkview pupils at the grade nine level and no conclusions can be drawn with regard to other grades or other areas.

B. The best qualified and most experienced teachers were selected each year as grade nine teachers. Consideration was given to their subject specialties and their preference as to class groups wherever possible. However, there was no possibility of ensuring equal teaching ability among the appointed staff.

C. Low ability classes were kept about four fewer in number of students than the other classes.

D. The Laycock Mental Ability Test, used as one of the bases for choosing matched pairs, was prepared in 1933. G. A. Ferguson[10] judged it to be a satisfactory instrument for appraising the mental level of school children with the age range (grades 4-10) specified. Students who had not taken it in grades five to eight were given the test in October of their grade nine year. V. R. Nyberg,[11] Provincial Coordinator of Testing and Research at Edmonton, in March, 1963, quoted a correlation of .72 between the Laycock and grade nine provincial achievement for Highlands School in Edmonton.

E. It was recognized that homogeneous grouping reduces heterogeneity only to a certain extent.

---

[10] G. A. Ferguson, "Laycock Mental Ability Test," in O. K. Buros, editor, The Third Mental Measurements Yearbook (New Brunswick: Rutgers University Press, 1949), p. 237.

[11] Statement by V. R. Nyberg at a Public School Administrators' meeting, Edmonton, March, 1963. Permission to quote secured.

F. Only the six examination subjects were used for measuring academic achievement.

G. No attempt was made to determine the specific causes of difference in achievement, if any were shown. Achievement is related to many factors, but this study was concerned statistically only with the relationship of grouping to achievement.

H. Achievement levels among the six subjects differed at the beginning of the experiment.

V. DEFINITION OF TERMS

Heterogeneous Grouping

Heterogeneous grouping may be defined as the formation of classes by the selection of students so that classes are balanced fairly equally as to sex and academic achievement. In this study it involved rank ordering by the sum of grade eight academic marks and alternately selecting students for each of the proposed grade nine classes. Some adjustment was required to limit the number of boys or girls to twenty in any class for Industrial Arts and Home Economics.

Homogeneous Grouping

Homogeneous grouping is defined in the Dictionary of Education as "the classification of pupils for the purpose of forming instructional groups having a relatively high degree of similarity, in regard to certain factors that affect learning." Here it referred to the rank ordering of all grade eight students on the basis of the sum of their academic marks in grade eight and the sectioning of the sequential list

into the desired number of grade nine classes. Students remained in their class group for all subjects.

Subject Grouping

Subject grouping is the classification of pupils by rank-ordering all grade eight pupils on the basis of their achievement in one subject, grade eight mathematics for example, and the sectioning of this sequential list into the desired number of grade nine mathematics classes. Subject grouping in this study was carried out in science and language as well as in mathematics. A student was included in different class groups if his achievement varied in the three subjects.

Achievement in all grade eight subjects was measured by teacher-made tests. Marks on the fall, the mid-term and the comprehensive final examinations were scaled to the grade nine subject achievement on the departmental examinations over the first three-year period with readjustment each year thereafter. The final grade eight marks were weighted on a 20-20-60 basis and adjusted to the nearest five per cent.

Academic Achievement

Academic achievement is that which is measured by the Grade Nine Departmental Examinations.

VI. ASSUMPTIONS

The assumptions for this study were as follows:

A. Teaching methods and techniques were adapted to best meet the inherent differences of groups and individuals under the three forms of grouping;

B. Curriculum adaptation consisted of the basic minimum for low groups and related enrichment for the superior groups;

C. The ability and efficiency of teacher personnel was fairly equal throughout;

D. There was little change in the ability level of pupil personnel in the area throughout the study;

E. The ability level of pupil personnel was above the city or provincial mean (lower ability groups could have differing relationships between achievement and grouping);

F. Pupil motivation was fairly equal throughout the study, and positively directed;

G. The availability of teaching aids, text books, references and materials was equivalent throughout;

H. Teacher, parent and pupil acceptance of the form of grouping was positive;

I. Teacher morale was not lowered by the group level of their teaching assignment and thus had little effect on achievement outcome;

J. Grade nine departmental examinations were valid and reliable measures of academic achievement.

VII. SUMMARY

Several factors suggest that a study of the relationship between ability grouping and pupil achievement on the grade nine departmental examinations should be significant. The rationale underlying ability grouping suggests certain advantages. Research on the subject has been inconclusive. There are many differences between the American and the

Canadian school systems. These differences, together with basic weaknesses in research techniques, suggest the need for further study locally. Interest in the problem is still high.

The purposes of the investigation are: first, to study the relationship between homogeneous grouping and the achievement of Parkview school pupils in six subjects on the provincial final examinations, using achievement under heterogeneous grouping in three previous years as the control; secondly, to study the relationship between heterogeneous, homogeneous and subject grouping and the achievement of Parkview school pupils in language, mathematics and science on the provincial final examinations.

CHAPTER II

RELATED LITERATURE AND RESEARCH

This chapter consists of two parts. The first, a review of the literature, deals with the history of ability grouping and the research directly connected with it. The second, related research, deals with teacher characteristics and class size, factors which may be related to academic achievement, but seem to have been ignored in research on ability grouping. Recent and future study will probably uncover other variables, unnoted in past research, whose relationship to achievement must be recognized in assessing the effects of grouping or other experimental procedures.

I. REVIEW OF THE LITERATURE

Ability grouping is not a recent innovation. It seems to have originated about the beginning of the 1920's during the "boom" movement in intelligence and achievement testing. Many psychologists and educational leaders felt that by the application of these new measuring instruments they could do much to make adjustments to individual differences in children.[1] Passow reported: "A steady flow of studies and discussions about grouping began in the early 1920's, reached a peak in

---

[1]Walter H. Sauvain, "A Study of the Opinions of Certain Professional and Non-Professional Groups Regarding Homogeneous or Ability Grouping," Contributions to Education, No. 596 (New York: Bureau of Publications, Teachers College, Columbia University, 1934), p. 1.

the mid-1930's and then dwindled rapidly."[2] Surveying the status of and trends in grouping in 1932, Billet observed:

> Perhaps no plan, method, or device for reaching the individual through class instruction has evoked more words written or spoken during the past ten years than homogeneous or ability grouping. The possible exception is individualized instruction.[3]

Always responsive to the key issues of the day the National Society for the Study of Education focused its 1936 Yearbook on the grouping of pupils.[4]

As the first fine faith in the I.Q. was questioned and the broad problems of grouping became more apparent, interest in grouping receded. Sauvain reported that the influence of the "Deweyists" appears to have had some effect at this time in de-emphasizing ability grouping and that many leading advocates of "development of the child through rich and varied experiences" took the stand that homogeneous grouping was not desirable in promoting "rich and varied" experiences.[5] The war years, too, saw a rising emphasis on the equality and the rights of the individual. In an article in the 1950 Encyclopedia of Educational Research Otto stated that "no research studies on ability grouping have been

---

[2]A. H. Passow, "The Maze of Research on Ability Grouping," Educational Forum, 26 (March, 1962), p. 281.

[3]A. H. Passow, Educational Forum, 26 (March, 1962), p. 281, citing R. O. Billett, The Administration and Supervision of Homogeneous Grouping (Columbia: Ohio State University Press, 1932), 159 pp.

[4]Guy M. Whipple, editor, "The Grouping of Pupils," Thirty-fifth Yearbook, Part 1, National Society for the Study of Education (Bloomington, Illinois: Public School Publishing Company, 1936), 315 pp.

[5]Sauvain, op. cit., p. 3.

reported during the past fifteen years."[6] While there actually were some studies in that period, the article accurately reflected the decline in research on grouping. In fact The Education Index for June, 1950 to May, 1953 listed only twenty-five articles on the subject.[7]

The past decade has been marked by a sharp upswing in grouping proposals and in studies of the effects and effectiveness of grouping. Sputnik in the autumn of 1957, the tremendous surge of technology and science and the growing realization that education is essential to national survival were some of the key factors which focused the spotlight on education. Passow reported:

> In the concern for improving the educational provisions for the gifted as well as for upgrading the quality of education of all students, questions about the relative advantages and disadvantages of ability grouping have once again been raised.[8]

Goodlad stated:

> Perhaps the most controversial issue of classroom organization in recent years is whether or not students of like ability should be grouped together for instructional purposes. The debate has been accompanied by some experimentation and research seeking to promote and appraise a given viewpoint.[9]

The Education Index, 1959 to 1961, listed ninety-nine articles or studies

---

[6]Henry J. Otto, "Elementary Education - III. Organization and Administration," in Walter S. Monroe, editor, Encyclopaedia of Educational Research (New York: The Macmillan Company, 1950), pp. 376-378.

[7]Dorothy R. Carpenter and E. L. Miller, editors, "Ability Grouping," The Education Index, Vol. 8 June 1950 - May 1953 (New York: The H. W. Wilson Company, 1953), p. 2.

[8]Passow, op. cit., p. 281.

[9]John I. Goodlad, "Classroom Organization--Horizontal Organization: Ability Grouping," in Chester W. Harris, editor, Encyclopaedia of Educational Research (New York: The Macmillan Company, 1960), p. 223.

on ability grouping.[10]

Reports indicated that grouping in the early 1950's, though not practised in the majority of schools, was still extensive, particularly in cities of large or moderate size which enable classes with several levels of ability, and that there were definite signs of increase. Shane, in a national sample of superior schools, found ability grouping used in 11 per cent, social maturity grouping in 18 per cent, chronological age grouping in 32 per cent, a composite base for grouping in some, and "wholesome social relationships" grouping in others.[11]

Buell since that time has reported that three-quarters of the junior high schools in the Philadelphia area grouped pupils by general ability in academic subjects in grades VII and VIII, while all did so in grade IX.[12] In a recent state-wide survey of ability grouping in Missouri public high schools, it was found that 39 per cent of the public secondary schools were grouping and that an additional six per cent were planning on using ability grouping in the 1960-61 school year.[13] A United States Office of Education survey of practices of elementary school administration and organization published in 1960 indicated that of 4,307 urban centers with populations of 2,500 or more, 16.9 per cent

---

[10]Minnie A Seng, editor, "Ability Grouping," The Education Index, Vol. 12, July 1959 - June 1961 (New York: The H. W. Wilson Company, 1961), pp. 3-4.

[11]H. G. Shane, "Grouping Practices," The Nation's Schools, 49 (May, 1952), pp. 72-73.

[12]C. E. Buell, "How Much Grouping in the Junior High School," The National Association of Secondary School Principals, Bulletin, 44 (April, 1960), pp. 49-60.

[13]Anthony Saville, "Ability Grouping in Missouri High Schools," Journal of Secondary Education, 37 (February, 1962), pp. 93-96.

had a basic policy of homogeneous grouping in grades I to VI, and that 34.4 per cent grouped homogeneously in grades VII to VIII. Schools using a policy of heterogeneous grouping and those using homogeneous grouping were in agreement that there would be an increase in homogeneous grouping in the future. The survey noted that "the methods of grouping and assigning pupils for instructional purposes represent another area of timely interest and one on which there is a great deal of public and professional discussion."[14]

The evidence seems conclusive in regard to the difficulty of reducing range in class ability by ability grouping. Cook[15] pointed to the tremendous extent of variability within each age and grade level. He also showed that any child may vary about four-fifths as widely among his own traits as his group will deviate from the mean of any one variable. He contended that a group cannot be homogeneous because there is variation in the specific abilities of each individual. He concluded his study by pointing out that when pupils were grouped on the basis of an achievement test battery which was heavily weighted in favor of reading and arithmetic that reduction in reading and arithmetic variability was only 20 per cent, while in subjects such as art, music, handwriting and spelling, the reduction of range approached zero.

Dockrell[16] presented evidence that ability grouping by I.Q. narrows the range only slightly. He stated strongly that merely

---

[14]Passow, op. cit., p. 282, citing Stuart E. Dean, Elementary School Organization and Administration Bulletin, No. 11, 1960 (Washington: United States Government Printing Office, 1960), pp. 67-73.

[15]W. W. Cook, "The Gifted and the Retarded in Historical Perspective," Phi Delta Kappan, 39 (March, 1958), p. 252.

[16]W. B. Dockrell, "Special Education for Gifted Children," Canadian Education and Research Digest, IILl (March, 1962), p. 43.

separating youngsters into different rooms on the basis of intelligence and achievement is valueless.

Dockrell[17] concluded that grouping at the elementary level does not result in higher academic achievement. He reported that findings at the junior high level are neither so clear nor so consistent. His tentative analysis of a large-scale investigation of 3,000 grade VII and VIII students in Edmonton indicated that students of superior ability as measured by previous achievement do not make greater progress in homogeneous groups. He further concluded that streaming at the junior high level seems valuable only if each subject is streamed separately and if specially prepared curricula are used for each group.

Thelen[18] stated that teachers should be matched for compatability with groups of children. Jackson and Getzels[19] held that grouping based on I.Q. would exclude many original creative thinkers from the top. Dockrell added that there is some British evidence that a thorough system of streaming (a student is in a particular stream for all his subjects) causes anxiety and maladjustment, but in American studies, partial segregation of the gifted seems to have no harmful effects.

Baker[20] pointed out that uncertainties about the nature and growth of intelligence, and problems involved in its measurement present

---

[17] Ibid., p. 40.

[18] Ibid., citing H. A. Thelen, Education--The Human Quest (New York: Harper Brothers, 1960).

[19] Ibid., p. 42, citing J. H. Getzels and P. W. Jackson, "The Meaning of Giftedness--An Examination of an Expanding Concept," Phi Delta Kappan, 40, pp. 75-77.

[20] H. S. Baker, "Second Thoughts on Grouping," Alberta Teachers' Association Magazine, 39 (March, 1959), p. 34.

difficulties and dangers to general ability grouping. He agreed with Vernon[21] that up to about age nine (except for physical or mental disability) there would seem to be no good case for ability grouping, but that by age thirteen, range and complexity of ability support some degree of grouping by general interest and ability. Where general ability grouping seems desirable, there should remain in the school program a sphere of common activity appropriate to the development of democratic citizenship.

Veatch questioned the use of published tests for placement purposes because they aim at averageness and so are not applicable in a given classroom for specific teaching plans. She stated:

> Grouping, I believe, must be a function and process of content, curriculum, and of its learning. . . .Grouping must come after particulars are isolated (in the classroom) in a preliminary, initiative kind of teaching action. Studies on grouping show that the way children are grouped has little significant effect. It is what the teacher is and does that makes a difference.[22]

Goldberg and Passow assessed the Talented Youth Project, a two-year study of grouping three thousand grade V and VI students in New York City on the basis of I.Q. Normal teaching procedures were maintained with specific, consistent adaptations in curricula and method being avoided. They stated:

> Ability grouping, per se, did not have any positive effect on the academic achievement of the fifth-and sixth-grade pupils. The variations in achievement were influenced more strongly by teacher and group differences in individual classrooms than they were by ability range, position, or even the intellectual ability of

---

[21]H. S. Baker, op. cit., p. 9, citing P. E. Vernon, "Education and the Psychology of Individual Differences," Harvard Educational Review, XXVIII:2 (Spring, 1958), pp. 102-103.

[22]Jeanette Veatch, "Grouping is the Function and Process of Content," Educational Leadership, 18 (April, 1961), p. 426.

the pupils.[23]

Carbone[24] found graded pupils scored significantly higher than non-graded pupils at the grade IV, V and VI level. He concluded that changes in structure to be effective must be accompanied by appropriate adaptations in instructional practice. He believed textbooks and related teaching materials may determine in large measure the kind of instruction, no matter what the organization.

Five reviews summed up the findings of research with regard to ability grouping. Otto[25] in 1950 stated that the evidence slightly favors the use of ability grouping as contrasted with heterogeneous grouping, particularly where standards, materials and methods are adapted to the group. The evidence regarding the attitudes of teachers toward ability grouping is that most teachers prefer to work with "homogeneous" rather than mixed groups. The evidence indicates greatest relative effectiveness for dull children, next greatest for average, and least (frequently harmful) for bright children. The evidence regarding particular grade levels or subjects in which ability grouping is particularly effective is inadequate to form a judgment. The indications are that in general the variability in achievement in ability groups is

---

[23]Miriam L. Goldberg and A. H. Passow, "The Effects of Ability Grouping," Education, 82 (April, 1962), p. 487.

[24]R. F. Carbone, "The Non-graded School: An Appraisal," Administrator's Notebook, X:1 (September, 1961), pp. 2, 4.

[25]H. J. Otto, "Elementary Education--III. Organization and Administration--Classification of Pupils," in Walter S. Monroe, editor, Encyclopaedia of Educational Research (New York: The Macmillan Company, 1950), p. 377.

reduced only 20 per cent by grouping.

Goodlad[26] in 1960 reiterated Otto's findings. In addition, pointing out the limitations in the related research, he stated:

> The question of assigning cause arises when ability groups supported by appropriate curricular and instructional adaptations are shown to be superior to nondifferentiated groups for which similar adaptations have not been made. Studies reporting research of this kind are meaningless for comparative purposes, although they may be useful for revealing the educational procedures that should accompany organizational changes.

The present study should not have been biased by these last two weaknesses. Informed teachers take into account individual differences with any form of grouping. However, the time element forces the teaching of the class group and ability grouping may enable the teacher to adapt more readily to the range of his students. In fact, if this is so, it should provide more time for individual differences. This in essence should be the source of any difference in academic achievement under ability grouping.

Wilhelms and Westby-Gibson[27] concurred with Otto and Goodlad. They suggested that the finding that teachers have tended to see grouping as somewhat easing their problems of instruction should not be taken lightly. They concluded that the supposed homogeneity of the subgroups is a myth, even though the ranges of differences have been reduced somewhat, but added that this does not apply at all equally to grouping by subjects, though it offers a warning even here. They suggested: "It is time to

---

[26] J. I. Goodlad, "Classroom Organization--Horizontal Organization: Ability Grouping," in Chester W. Harris, editor, Encyclopaedia of Educational Research (New York: The Macmillan Company, 1960), p. 224.

[27] F. T. Wilhelms and D. Westby-Gibson, "Grouping: Research Offers Leads," Educational Leadership, 18 (April, 1961), p. 411.

exploit the possibilities that invention provides, and to go direct to the unique individual without first submerging him in a type."[28] One might add here that we are a long way from the one pupil-one teacher ideal. Group teaching will probably be with us for some time. It should be noted too that Educational T.V. directs its programs to a specific audience level.

Ekstrom's[29] critical review for the Educational Testing Service attempted to account for the inconsistency of the findings. Thirty-one studies involving experimental controls failed to show consistency in the effectiveness of homogeneous grouping related to age, ability level, course content or method of instruction. Experimental results differed greatly because of the wide variety of experimental conditions, methods and purposes. Few studies had much in common in content, method, or type of subjects used. Not many attempts were made to control more than a few of the possible variables affecting the learning situation. Few of the experimenters took into consideration the possibility that factors other than grouping could influence the test scores. In many cases experiments were too brief in duration to permit significant changes to be observable. The use of matched pairs of students was often a weak technique since the equating was usually based on intelligence or achievement, while motivational factors that prompted some students to enter special or experimental classes and may have influenced others to remain with the usual group

---

[28] Ibid., p. 476.

[29] R. B. Ekstrom, "Experimental Studies of Homogeneous Grouping: A Critical Review," School Review, 69 (Summer, 1961), pp. 222-223.

were overlooked. Several studies used only a test of general scholastic aptitude to section classes, although it is generally considered more appropriate to combine this information with knowlege of pupils' achievement in each subject and to use the combined information as a basis for grouping.

The major deficiency in most of these studies that compared homogeneous and heterogeneous grouping was failure to provide for differentiation of course content and method according to the level of ability. Ekstrom concluded that results favoring homogeneous grouping were strongly evident in experiments that specifically provided for differentiation of methods and materials according to the students' ability and that made an effort to push bright, homogeneous classes.

This study avoided the weakness of matching pairs on intelligence alone. Pairs were selected on the basis of sex, Laycock I.Q., attendance, chronological age, and the provincial grade nine ability test. A parallel analysis was carried out for three ability levels using individuals selected randomly. Sectioning of classes was based on pupil achievement in grade eight academic subjects. This involved three common examinations which in the writer's opinion, when combined had some degree of reliability and validity as measures of achievement.

In the most recent review, Passow summed up the findings by quoting Rock:

> Experimental studies of grouping have failed to show consistent, statistically or educationally significant differences between the achievement of pupils in homogeneous groups and pupils of equal

ability in heterogeneous groups.[30]

He further added, quoting Miller and Otto: "The studies seem to indicate that homogeneous classification may be effective if accompanied by proper adaptation in methods and materials.[31]

Passow listed the following reasons[32] as responsible for the difficulty of generalizing from available research:

1) Studies differ in the number of students, the number of groups and the size of classes involved;
2) Studies vary considerably in scope of aim and purpose;
3) Studies differ in duration;
4) Studies differ in the adequacy of the selection bases and the means of matching experimental and control groups;
5) Studies differ in deployment of teachers in various groups;
6) Studies differ in instruments and techniques used in evaluating changes in students;
7) Studies have generally failed to assess the effect of grouping on teachers and administrators.

Baughman and Schoonmaker, reporting on grouping practices in junior high schools, said:

---

[30] A. H. Passow, "The Maze of Research on Ability Grouping," Educational Forum, 26 (March, 1962), p. 283, citing R. T. Rock, Jr., "A Critical study of Current Practices in Ability Grouping," Educational Research Bulletin, Nos. 5 and 6 (Catholic University of America, 1929).

[31] Ibid., quoting W. S. Miller and H. J. Otto, "Analysis of Experimental Studies in Homogeneous Grouping," Journal of Educational Research, 21 (January-March, 1930), pp. 95-102.

[32] Ibid., pp. 285-287.

> According to some reports, ability grouping stimulates groups and individuals to excel, accustoms superior students to intensive mental activity, relieves the student with lesser ability from embarassment by his peers and makes possible the adjustment of the curriculum to the individual's needs. . . .In spite of the varieties in vogue, the consensus seemed to favor ability grouping in the academic subjects, but heterogeneous grouping in homeroom and all other subjects.[33]

No mention was made of the fact that placement in the low group does label the student in the eyes of his peers.

Tyler, quoting Cook on intra-individual variability, stated:

> Cook's conclusions on this matter are still pertinent:
> The research reported here is not meant as an argument against homogeneous grouping. If we can reduce the heterogeneity of instructional groups by as much as 20 per cent, that at least helps some. But it is very important to know the limitations of such grouping. . . .[34]

Buell, too, held a similar opinion when he stated:

> For a part of their school life, junior high school pupils should have opportunities to develop their special abilities without interference from other pupils of much lesser ability and interest who might possibly hold them back. At other times in their school life they should live and work as a social group with pupils of varied abilities and interests.[35]

"The search for better class organization for instruction is complex and elusive," Goodlad wrote in 1963. He further added: "Inter-class grouping is a practical necessity, if only to utilize effectively both available teachers and available space." While he questioned the

---

[33]M. D. Baughman and D. Schoonmaker, "Grouping Practices in Junior High," The Clearing House (October, 1961), pp. 111-112.

[34]F. T. Tyler, "Intra-individual Variability," National Society for the Study of Education, Yearbook 61, Part I (Chicago: University of Chicago Press, 1962), p. 174, citing W. W. Cook, "Grouping and Promotion in the Elementary Schools." Series on Individualization of Instruction, No. 2 (Minneapolis: University of Minnesota Press, 1941), p. 33.

[35]C. E. Buell, "What Do We Believe About Grouping For Instruction in the Junior High School?" National Association of Secondary School Principals Bulletin, 46 (October, 1962), pp. 18-19.

reduction in pupil variability he still held that: "selective grouping and regrouping by achievement sometimes is useful, particularly at the secondary school level."[36]

In 1964, Balow,[37] studying the effects of homogeneous grouping in grade seven mathematics, found that in each section children who knew the least at the beginning of the year grew the most. He concluded that teachers were gearing their approach to the least capable students. While this may not be a tendency of all teachers, it does contain certain implications to the advantage of ability grouping.

II. RELATED RESEARCH

The competence of teachers is obviously of primary importance in any study dealing with academic achievement. Three local studies have investigated the relationship of certain teacher qualifications and student achievement.

Lindstedt[38] in 1960 reported a study on the relationship of achievement in grade nine mathematics to teaching experience, years of education, educational background in the subject area and subject preference. He found that teachers with ten or more years of experience are

---

[36] J. I. Goodlad, "Planning and Organizing for Teaching," National Educational Association Project of the United States (Washington, 1963), pp. 71, 91.

[37] I. H. Balow, "The Effects of "Homogeneous" Grouping in Seventh-Grade Arithmetic," The Arithmetic Teacher, XI: 3 (March, 1964), 191.

[38] S. A. Lindstedt, "Teacher Qualifications and Grade Nine Mathematics Achievement," The Alberta Journal of Educational Research, VI:2 (June, 1960), p. 83.

more competent than teachers with less experience; teachers with four or more years of education are more competent than teachers with less education; teacher competence is consistently increased when years of education are combined with years of experience; the number of university mathematics courses taken does not reflect any significant difference in grade nine mathematics achievement; and that teachers who prefer the mathematics-science field have pupils with a higher average standing in mathematics.

Eddy[39] in 1963 reported a similar positive relationship for grade nine social studies between academic achievement and number of years of professional education, teaching experience and subject preference. His finding of a positive relationship for the number of university-level social studies courses differed with that of Lindstedt for mathematics. Eddy also found a positive relationship for schools with a larger number of teachers.

Wasylyk,[40] on the other hand, found a very significant increase in mathematics achievement with increase in the number of mathematics courses taken by Alberta grade twelve teachers. It should be noted that, in these studies, no inference could be made from subject to subject or from grade to grade. One might surmise that a university subject background would be required more for grade twelve mathematics than for

---

[39]W. P. Eddy, "Teacher Characteristics and Grade Nine Social Studies Achievement," The Alberta Journal of Educational Research, IX (December, 1963), p. 261.

[40]E. Wasylyk, "The Relation between Selected Teacher Characteristics and Student Achievement in Grade Twelve Mathematics," (Unpublished Master's thesis, The University of Alberta, Edmonton, 1961).

grade nine mathematics.

The above evidence suggested an examination of means for professional education and teaching experience in this study. This is reported in chapter three. There was, of course, no way of controlling the situation. The mean number of years of professional education of teachers were: heterogeneous grouping--4.56 years; homogeneous grouping--3.22 years; subject grouping--3.26 years. It should be noted that the important fourth year of training favored the control or heterogeneous period.

The mean number of years of teaching experience for this study was as follows: heterogeneous--16.76 years; homogeneous--6.94 years; subject grouping--6.88 years. Here too, any advantage favored heterogeneous grouping. The differences in both factors were similar for all subjects. Tables II and II, in chapter three, show the data for this study.

It has been suggested that class load or enrolment may bear some relationship to pupil achievement. Clarke and Richel[41] concluded that a combination of smaller classes and better qualified teachers produces better results on grade nine examinations. However, one might raise the question as to whether the class-load relationship is the same for all subjects.

Marklund[42] in a Swedish study at the grade six level said:

---

[41] S. C. T. Clarke and S. Richel, "The Effect of Class Size and Teacher Qualifications on Achievement," Research Monograph Number 5, (Edmonton: The Alberta Teachers' Association, April, 1963), 71.

[42] S. Marklund, "Scholastic Attainments as Related to Size and Homogeneity of Classes," Educational Research, VI:1 (November, 1963), 64.

> Although it cannot be said that class size lacks relevance for the achievement of pupils, these investigations have shown that differences fail to appear even when such factors as level and homogeneity of intelligence, standard scores and social pattern, etc., are controlled.

The data for this study suggested that the advantage, if any, from smaller class enrolment rested with homogeneous grouping and subject grouping. The mean class enrolment for heterogeneous grouping was 34.0, for homogeneous grouping 30.5 and for subject grouping 30.8.

It might be assumed that this factor favoring homogeneous and subject grouping would counteract the advantage in teacher education and teaching experience favoring heterogeneous grouping.

III. SUMMARY

While the maze of research on grouping still leaves the question undecided, for the reasons outlined in detail by Ekstrom, Passow and others, certain indications are becoming evident. First, homogeneous grouping, in spite of the difficulties of sectioning, may be effective if accompanied by differentiation of methods and materials and the active participation of teachers and pupils. Secondly, grouping finds its greatest support and acceptance at the secondary school level where the spread in individual differences reaches a maximum. Thirdly, research is being urged in the direction of subject grouping where greater homogeneity in a particular aptitude and interest may be obtained. Fourthly, research is concerned with the optimum development of the individual child whatever the level of his ability may be. Fifthly, while many educationists believe in ability grouping as one means of meeting individual differences, they generally caution the teacher

against the assumption of homogeneity in any class.

Other organizational leads are being explored at present in the attempt to meet individual differences. Team teaching, with its large and small groups and individual study periods, is one of these promising new directions in education. Programmed learning and programmed textbooks is another. While these are directed in the main towards the individual, it seems certain that the teacher will be concerned with classroom groups for the foreseeable future. The ultimate of one pupil-one teacher is obviated by practical and financial considerations. The question of the effectiveness of grouping forms will be pertinent even in these new directions. Clearly further research is needed to extend the limits of what has been learned about grouping up to now and to make more definite what so far are just indications.

It has been recognized that studies of ability grouping involve many other important variables. These may intrude on short or long-term studies. Some are beyond the control of the designer. It is felt, however, that where they exist they should be reported and in the absence of statistical evidence their possible effect should be noted on a judgmental basis. There is some evidence that three of these factors, professional education, teaching experience and classroom load, are related to grade nine achievement.

The present study was designed in an attempt to determine the relationship between ability grouping and the achievement of Parkview grade nine pupils. The conclusions reached should aid in determining future class organization in that school.

CHAPTER III

DESIGN OF THE STUDY

I. SOURCES OF DATA

Data for this thesis were obtained from a number of sources. Stanine scores and the School and College Ability Test percentiles were obtained from the achievement record sheets sent to the school by the Examinations Branch, Department of Education.

Composite academic scores for sectioning classes were obtained from the grade eight class promotion sheets utilized by the Edmonton Public School Board.

Sex, chronological age, attendance for the grade nine year and Laycock I.Q. were provided by classroom registers, Cumulative Record cards and Report Cards from other schools.

Teacher characteristics--professional training and teaching experience--were obtained from the Department of Education "A" cards and by personal contact.

II. THE POPULATION

The population consisted of all grade nine students at Parkview school for the eight school years between September, 1956 and June, 1964. Excluded were students who transferred out during the year or who did not write the departmental examinations for medical reasons.

TABLE I

PARKVIEW GRADE IX CLASS ORGANIZATION OVER THE EIGHT-YEAR PERIOD
1956 TO 1964

	1956-57	N	1957-58	N	1958-59	N
Heterogeneous Grouping	Class 1	32	Class 2	37	Class 4	34
			Class 3	36	Class 5	34
					Class 6	31
Mean class enrolment:						34.0
	1959-60	N	1960-61	N	1961-62	N
Homogeneous Grouping	Class 7	31	Class 11	29	Class 15	31
	Class 8	33	Class 12	30	Class 16	33
	Class 9	33	Class 13	29	Class 17	33
	Class 10	28	Class 14	26	Class 18	30
Mean class enrolment:						30.5
	1962-63	N	1963-64	N		
Subject Grouping	Class 19	31	Class 22	33		
	Class 20	32	Class 23	31		
	Class 21	27				
Mean class enrolment:						30.8

III. ORGANIZATION OF THE POPULATION

The organization of classes is shown in Table I.

Heterogeneous Grouping

In September, 1956, the one grade nine class formed a heterogeneous group. In September of 1957 and 1958 heterogeneous classes were formed through balancing them by the sum of academic achievement in grade eight and by sex. Common final examinations in grade eight were weighted 60 per cent of the final mark, with 20 per cent each to the October and

January examinations. The achievement in academic subjects of transfers from other schools was used to place them heterogeneously.

Homogeneous Grouping

In August of the three following years (1959-60-61) grade nine classes were formed on a homogeneous basis. Common grade eight examinations were given and the final mark awarded on a sixty-forty basis. Marks were scaled to the curve of the average of previous grade nine departmental examinations. The academic subject marks (literature, social studies, language, mathematics and science) were totalled and students were arranged in rank order by their total scores. Class groups were then formed by sectioning the class lists. In September of the three years transfer-outs were deleted and transfer-ins were positioned on the basis of their academic subject achievement at their previous school.

Subject Grouping

In August of the two following years (1962-63) grade nine classes were organized on the same homogeneous basis as previously. In September mathematics classes were formed by sectioning all grade nine students rank-ordered on the basis of their final grade eight mathematics mark. The same procedure was carried out for science and language. Literature and social studies were taken in the homogeneous home room. Students moved for the other three academic subjects.

Matched Pairs

All students for the heterogeneous period were arranged in rank order by Laycock I.Q.; chronological age, attendance for the grade nine

year, School and College Ability Test percentiles and stanine scores were listed as well. The same procedures were carried out for all students in the homogeneous period.

Pairs were then matched on the basis of sex, chronological age--within six months, Laycock I.Q.--within five points, attendance--within fifteen days, and School and College Ability Test percentile--within fifteen points. Level one consisted of thirty-two pairs between Laycock I.Q. 146 and 117; level two, thirty-two pairs between 117 and 107; level three, thirty-two pairs between 107 and 82.

The same procedure was carried out for the subject-grouping period except that it was not possible to stay within the fifteen point limit for the School and College Ability Test.

The data are shown in Tables XLII, XLIII, and XLIV in Appendix A.

Random Sample

Because of the differing views held with respect to the use of matched pairs, it was decided to use the random sample technique in a parallel analysis. Students were arranged in rank order by Laycock I.Q. and sectioned as shown in Table II.

Random numbers were taken from the thirty-page table of 105,000 random digits prepared by the Bureau of Transport, Economics and Statistics of the Interstate Commerce Commission, Washington, D.C., beginning at Line 1 and Column 3 and proceeding downward.[1] Thirty-two students were drawn for each cell. The data are shown in Tables XLV, XLVI, and

---

[1] H. M. Walker and J. Lev, Statistical Inference (New York: Holt, Rinehart and Winston, 1953), p. 484.

TABLE II

ORGANIZATION OF POPULATION FOR MATCHED PAIRS AND RANDOM SAMPLING

	Laycock I.Q.	Heterogeneous	Homogeneous	Subject Grouping
Matched Pairs	154-117	54	144	69
	117-107	60	108	43
	107- 82	77	104	44
Random Sample	154-123	27	84	60
	122-108	76	165	55
	107- 85	78	107	41

XLVII in Appendix A.

The Laycock I.Q. range for level two in the random sample was increased to provide a broader ability base for that group. For this reason the random sample must be considered as different from the matched pairs.

The means for four characteristics chosen for matching pairs are shown in Table III, together with those of students selected by random numbers. It would appear that matching has equalized means in these characteristics only a little better than those for random sampling. Random means for Laycock I.Q. and SCAT percentile were consistently somewhat higher than matched means only at level one.

IV. RELATED FACTORS

It has already been indicated (Chapter II, p. 29) that any advantage derived from greater professional education and teaching experience

TABLE III

MEANS OF SELECTED CHARACTERISTICS FOR MATCHED PAIRS AND RANDOM SAMPLES

Level	HETEROGENEOUS				HOMOGENEOUS				SUBJECT GROUPING			
	Laycock IQ	SCAT Per-centile	Atten-dance	Chrono-logical Age June 1	Laycock IQ	SCAT Per-centile	Attendance	Chrono-logical Age June 1	Laycock IQ	SCAT Per-centile	Atten-dance	Chrono-logical Age June 1
M1	125.1	90.1	185.6	14/11	125.4	91.2	190.2	14/11	125.4	90.4	186.3	14/9
M2	112.0	76.9	186.5	15/0	111.9	77.3	189.2	14/11	113.1	72.8	184.5	14/10
M3	100.4	51.5	185.9	15/4	100.3	52.5	187.8	15/3	100.9	48.3	185.6	15/2
$\bar{X}_M$	112.5	72.8	186.0	15/1	112.5	73.7	189.1	15/0	113.1	70.5	185.5	14/11
R1	127.9	90.3	184.1	14/9	129.3	92.4	189.8	14/8	132.8	92.3	185.5	14/8
R2	114.0	74.3	184.7	14/11	115.3	76.7	186.9	14/11	114.8	73.4	183.6	14/10
R3	100.2	49.1	184.8	15/5	100.6	49.9	189.3	15/2	100.2	49.7	183.7	15/4
$\bar{X}_R$	114.0	71.2	184.5	15/0	115.1	73.0	188.7	14/11	115.9	71.8	184.4	14/11

M1: Means for matched data, level 1. R1: Means for random data, level 1

rested with heterogeneous grouping. Table IV shows the professional education of Parkview grade nine teachers in years. The data for teaching experience are shown in Table V. The difference in professional education

TABLE IV

ACADEMIC AND PROFESSIONAL EDUCATION OF PARKVIEW GRADE NINE TEACHERS IN YEARS

		Mean Number of Years of Professional Education					
Years	N	Literature	Soc. St.	Language	Mathematics	Science	Mean
1956-7	2	5	5	5	5	5	
1957-8	3	4	5	5	4	4	
1958-9	3	4.3	4.7	4.7	4	4	
1956-59	2.7	4.4	4.9	4.9	4.3	4.3	4.56
1959-60	5	4	4	4	3	3	
1960-1	6	4	4	4	2.5	2.5	
1961-2	6	3	2.5	2.5	2.5	2.5	
1959-62	5.7	3.7	3.5	3.5	2.7	2.7	3.22
1962-3	6	2.7	2.3	3.7	3.3	3.3	
1963-4	5	4	3	3	3.5	3.5	
1962-64	5.5	3.4	2.7	3.4	3.4	3.4	3.26

N: Number of teachers involved.

TABLE V

TEACHING EXPERIENCE OF PARKVIEW GRADE NINE TEACHERS IN YEARS

		Mean Number of Years of Teaching Experience					
Years	N	Literature	Soc. St.	Language	Mathematics	Science	Mean
1956-7	2	18	18	18	23.7	23.7	
1957-8	3	6	20.5	12.5	16.7	11.3	
1958-9	3	16.7	21	15.7	17.3	12.3	
1956-59	2.7	13.6	19.8	15.4	19.2	15.8	16.76
1959-60	5	0	15	7	15.5	7.5	
1960-1	6	2.2	4	4	9.5	9.5	
1961-2	6	3.8	2.5	2.5	10.5	10.5	
1959-62	5.7	2.0	7.2	4.5	11.8	9.2	6.94
1962-3	6	5.3	3.5	5.7	9.8	9.8	
1963-4	5	4.0	4.5	4.5	10.8	10.8	
1962-64	5.5	4.7	4.0	5.1	10.3	10.3	6.88

N: Number of teachers involved.

between homogeneous grouping and subject grouping was only .04 years; the difference in teaching experience only .06 years.

Mean class enrolment for heterogeneous grouping was 3.5 higher than that for homogeneous grouping; 3.2 higher than that for subject grouping. Any advantage here might counteract the former. The data are shown in Table I, page 33.

No attempt was made to assess pupil or teacher acceptance of grouping and its effect on morale other than by subjective means. An attempt was made to keep the teaching load equal and to assign teachers the level and subject they preferred.

V. METHODS OF ANALYSIS

Experimental Model

Since the methods of grouping, ability levels and subjects did not represent a random sample from the potential number of their kind, all variables or factors were considered fixed. Ferguson stated that:

> . . .in psychological experiments different methods are examples of fixed factors, and that while interpolation between levels may be possible, such variables are usually regarded as fixed.[2]

The model was therefore regarded as finite and fixed.

Statistical inferences drawn from the analysis of matched pairs data were restricted to the parent population of matched pairs for the years listed. Those drawn from the analysis of random data could be extended to the grade nine population for Parkview school.

With respect to "judgmental" inference, Lindquist stated:

---

[2]G. A. Ferguson, Statistical Analysis in Psychology and Education (Toronto: McGraw-Hill, 1959), p. 250.

> The extent to which he may extrapolate his inferences to a real population depends upon his own judgment of the extent to which the relative effects of the treatments are the same for the real as for the hypothetical population. (He need not assume that the absolute effects of each treatment are the same for both these populations, but only that the relative effects of the treatments are the same.)[3]

Ray, dealing extensively with the use of matching in experimental design said:

> The matched group design offers possibilities for increasing the precision of an experiment. . . .Small treatment differences will be detected more frequently. Significant results will more often be announced when they should be.[4]

Guilford (1956),[5] Dixon and Massey (1957),[6] Walker and Lev (1958),[7] and McNemar (1962)[8] also supported this view.

With these two points in mind, it might be contended on a judgmental basis at the very least, that whatever treatment was most effective for matched groups was also most effective for all grade nine students in Parkview school.

---

[3]E. F. Lingquist, Design and Analysis of Experiments in Psychology and Education (Boston: Houghton Mifflin Company, 1953), p. 74.

[4]W. S. Ray, An Introduction to Experimental Design (New York: MacMillan, 1960), p. 103.

[5]J. P. Guilford, Fundamental Statistics in Psychology and Education (Toronto: McGraw-Hill, 1956), p. 189.

[6]W. J. Dixon and F. J. Massey, Introduction to Statistical Analysis (Toronto: McGraw-Hill, 1957), p. 124.

[7]H. M. Walker and J. Lev, Elementary Statistical Methods (New York: Holt, Rinehart and Winston, 1958), p. 227.

[8]Q. McNemar, Psychological Statistics (New York: John Wiley and Sons, 1962), p. 85.

Analysis of Variance: Three-Way Classification

The F or variance ratio is applicable in a wide variety of situations. The general requirement is that there are two independent estimates of variance (for example, a control--heterogeneous and an independent variable--homogeneous) which estimates are, on the basis of the null hypothesis, regarded as estimates of the same population value. If F is sufficiently large, the null hypothesis becomes suspect, and we draw a positive conclusion that there is a significant difference within a certain chance probability.

Variances are additive to a total variance, or, in other words, variation can be broken down into component parts so as to permit specification of the relative importance of the component sources. Simply, an individual's score may be written as a deviation from the total mean in terms of the deviation of his score from his group mean and the deviation of the group mean from the total mean, which indicates two sources of variation. It should be noted that the analysis of variance does not divide the square of the standard deviation into additive parts, but rather the sum of squares $\sum (X - \bar{X})^2$ into additive parts.

In the analysis of variance (three-way classification) the one set of data is used to test the null hypotheses regarding the separate influence of the three independent variables: here, grouping methods, subjects and ability levels. The total sum of squares is partitioned into eight parts: a between-blocks (grouping methods), a between-rows (ability levels) and a between-columns (subjects) sum of squares; a blocks x rows, a blocks x columns and a rows x columns interaction sum of squares; a three-way blocks x rows x columns interaction sum of squares;

and the remainder, a within-cells sum of squares.

The analysis of variance (three-way classification) provides an over-all test of the significance of the difference between means. It permits a refined estimate of error by allowing for variation due to one or more variables.

The pattern followed in this study was outlined by Lindquist[9] and also McNemar.[10]

The first analysis, a 2 x 3 x 6 design, tested general relationships involving heterogeneous and homogeneous grouping. It included two blocks (grouping), three levels (ability) and six columns (subjects), with thirty-two cases in each cubicle. The analysis was carried out for matched pairs data and also for random data.

The null hypotheses were taken as in Ferguson:[11]

1. Grouping: $H_A : \sigma^2_A = 0$
2. Levels: $H_B: \sigma^2_B = 0$
3. Subjects: $H_C: \sigma^2_C = 0$
4. Interaction: Grouping x Levels: $H_{AB}: \sigma_{AB}{}^2 = 0$
5. Interaction: Grouping x Subjects: $H_{AC}: \sigma_{AC}{}^2 = 0$
6. Interaction: Levels x Subjects: $H_{BC}: \sigma_{BC}{}^2 = 0$
7. Interaction: Grouping x Levels x Subjects: $H_{ABC}: \sigma_{ABC}{}^2 = 0$
8. Interaction: Within cubicles: $H_e: \sigma^2_e = 0$.

The second analysis was a 3 x 3 x 3 design testing general relationships between the three methods of grouping, three levels (ability)

---

[9]Lindquist, op. cit., p. 228. [10]McNemar, op. cit., p. 320.

[11]Ferguson, op. cit., p. 249.

and three columns (language, mathematics and science) with thirty-two cases in each cubicle. The analysis was carried out for both sets of data.

Error Term

In regard to choosing the denominator for F ratios, Ferguson[12] stated: "For fixed models with $n > 1$ the correct error term for testing interaction, row and column effects is S_w^2."

McNemar[13] in regard to the fixed constants model with m different individuals in each of the cells wrote: "S_w^2 is the proper error term for testing all three main effects, all three two-way interactions and the three-way interaction."

In addition, Winer added:

> By way of summary, it should be noted that there is no wide-spread agreement among statisticians on the wisdom of pooling procedures. . . .Those statisticians who adhere to the "never pool" rule demand a completely specified model prior to the analysis of the experimental data. This position has much to recommend it.[14]

The error term chosen for F ratios throughout was therefore S_w^2.

Analysis of Variance: Two-Way Classification

In this type of analysis the one set of data is used to test the null hypotheses regarding the separate influence of two independent variables: here, grouping methods and ability levels. The total sum of squares is partitioned into four parts: a between-rows (ability levels)

---

[12] Ibid., p. 251. [13] McNemar, op. cit., p. 332.

[14] B. J. Winer, Statistical Principles in Experimental Design (Toronto: McGraw-Hill, 1962), p. 207.

and a between-columns (grouping methods) sum of squares; an interaction (levels x methods) sum of squares; and a residual within-cells sum of squares. The analysis helps locate sources of over-all differences.

The pattern followed in this study was outlined by Ferguson.[15] The first group tested relationships between heterogeneous and homogeneous grouping for each of the six subjects. They consisted of a two-column (methods) by three levels (ability) design. Analyses were carried out for both sets of data.

The second group tested relationships between the three methods of grouping and each of the three subjects, language, mathematics and science. They consisted of a three-column (methods) by three levels (ability) design. Analyses were carried out for both sets of data.

t-Tests

Since the matched pairs were considered to be a single group of subjects studied under separate experimental conditions, the test used was that for the significance of the difference between means for correlated samples. Ferguson's[16] difference method was used for matched-pair data where significance had been indicated by analysis of variance.

For random data the significance of the difference between means for independent samples was determined where significance had been indicated by analysis of variance. Ferguson's[17] pattern was followed.

The two-tailed t-test was used since it was not known at the beginning which means would be higher and the choice of test should be independent of the data.

---

[15] Ferguson, op. cit., p. 256. [16] Ibid., p. 138. [17] Ibid., p. 137.

Assumptions Underlying the Analysis of Variance

In the mathematical development of the analysis of variance a number of assumptions are made. Gross departure from these assumptions can lead to erroneous conclusions. With most sets of real data the assumptions underlying the analysis of variance are, at best, only roughly satisfied. The analysis has one advantage in that reasonable departures from the assumptions of normality and homogeneity may occur without seriously affecting the validity of inferences drawn from the data.

One assumption is that distributions of the variables in the populations from which the samples are drawn are normal. For large samples the normality of the distributions may be tested using a test of goodness of fit as illustrated in Ferguson.[18] This was carried out for both matched pairs and random data. All distributions were normal except for heterogeneous grouping where the departure was not gross ($p < .04$). A summary of the calculations is shown in Table VI.

Although F tests in the analysis of variance are robust with respect to the assumption of homogeneity of error variance, a rough but simple check may be made on this second assumption through the use of the F_{max} statistic.[19] Tests were carried out using total stanine scores for heterogeneous and homogeneous grouping, and using the sum of stanine scores in language, mathematics and science for homogeneous and subject grouping. A summary of the calculations is shown in Table VII.

For the former, F_{max} ratios of 2.08 (matched pairs) and 1.76

---

[18] Ibid., p. 164. [19] Winer, op. cit., p. 239.

TABLE VI

SUMMARY OF TESTS OF THE NORMALITY OF DISTRIBUTION FOR MATCHED PAIRS AND RANDOM DATA

Goodness of Fit of Normal Frequencies To Frequency Distribution of Aggregate Stanine Scores				
Grouping	X^2	df	p	Distribution
Matched Heterogenous	11.83	5	$.05 > p > .02$	Not quite normal, departure not gross.
Homogeneous	8.46	5	$.20 > p > .10$	Normal
Subject Grouping	4.38	5	$.50 > p > .30$	Normal
Random Heterogeneous	11.54	5	$.05 > p > .02$	Not quite normal, departure not gross
Homogeneous	4.93	5	$.50 > p > .30$	Normal
Subject Grouping	1.20	5	$.95 > p > .90$	Normal

TABLE VII

SUMMARY OF TESTS FOR HOMOGENEITY OF ERROR VARIANCE THROUGH THE USE OF THE F_{max} STATISTIC

Comparison	SS(largest)	SS(smallest)	F_{max}	$F_{.95}(6,31)$	$F_{99}(6,31$	Hypo of Homo
Matched* Hetero/Homo	1470.7	701	2.08	2.41	3.44	Tenable
Matched° Homo/Subject	711.9	193.5	3.68	2.41	3.44	Critical, not gross
Random* Hetero/Homo	1654	938	1.76	2.41	3.44	Tenable
Random° Homo/Subject	728.9	303.9	2.40	2.41	3.44	Tenable

*Stanine sum for six subjects.

°Stanine sum for language, mathematics and science.

(random) were below the critical .05 level of 2.41 indicating that the hypothesis of homogeneity of variance could be considered tenable. For the latter, F_{max} ratios of 3.68 (matched pairs) and 2.40 (random) were found. The finding for matched pairs was critical but not gross. It was therefore assumed that the assumption of homogeneity of variance was met fairly well for all data with the exception of some reservation regarding subject grouping matched pairs. A more stringent level of significance would be required for the latter.

A third assumption is that the observations within each category must be random samples. It has been reported that the analysis of variance for the matched group design gives approximately the same results as the randomization test when the group variances are homogeneous or nearly so.[20] The analysis using random data should have met this requirement as well.

There were no grounds to suspect the fourth assumption that the effects of various factors on the total variation were additive, as distinct from multiplicative.

VI. TREATMENT OF THE DATA

The analysis of data is presented in chapter four. It consists of two main parts and is carried out in the method already indicated for both matched and random data. The first part examines the relationships between heterogeneous and homogeneous grouping for the six subjects. The second part examines relationships between heterogeneous, homogeneous

---

[20] Ray, op. cit., p. 102.

and subject grouping for language, mathematics and science. Summaries of the analyses of variance are included and the findings are summarized for each part.

Chapter five includes a summary of the findings, the conclusions drawn and some implications. Certain recommendations are made regarding grouping as a form of classroom organization and finally suggestions are made for future study.

CHAPTER IV

ANALYSIS OF DATA

In this chapter the data are analyzed with the objective of resolving the two main problems. The first part is concerned with relationships between achievement and the two methods of grouping, heterogeneous and homogeneous. The second part is concerned with the relationship between achievement under a third method, subject grouping, and achievement under the first two methods.

I. ANALYSIS OF VARIANCE: HETEROGENEOUS/HOMOGENEOUS GROUPING

The analysis carried out on both matched and random data investigated relationships between two methods of grouping (heterogeneous and homogeneous), three ability levels, and six subjects (reading, literature, social studies, language, mathematics and science). The blocks (A) represent methods, the rows (B) levels and the columns (C) subjects.

In the analysis of variance: three-way classification the following abbreviations were used:

$\sum_{a=1}^{A}\sum_{b=1}^{B}\sum_{c=1}^{C} X_{abc}^2$ = the sum of the squares of each stanine score in all the cells (36).

$\sum (\sum X_{abc})^2$ = the sum of the squares of the totals for each cell.

$\sum_{a} (\sum_{b}\sum_{c} X_{abc})^2$ = the sum of the squares of the totals for each block.

$\sum_{b} (\sum_{a}\sum_{c} X_{abc})^2$ = the sum of the squares of the totals for each level (including both blocks).

$\sum_{c} (\sum_{a}\sum_{b} X_{abc})^2$ = the sum of the squares of the totals for each subject (including both blocks).

T^2 = the square of the sum of all the stanine scores.

$\sum_a \sum_b (\sum_c X_{abc})^2$ = the sum of the squares of the totals for each level (three in each block).

$\sum_a \sum_c (\sum_b X_{abc})^2$ = the sum of the squares of the totals for each subject (six in each block).

$\sum_b \sum_c (\sum_a X_{abc})^2$ = the sum of the squares of the totals for the corresponding cells in each block (eighteen totals).

Tables VIII and IX summarize the analysis of variance: three-way classification for matched and random data respectively. For matched data the relationship between achievement and each of grouping, ability levels and subjects was significant at the .001 level. All interactions

TABLE VIII

SUMMARY OF ANALYSIS OF VARIANCE FOR DATA OF APPENDIX B TABLE XLVIII HETEROGENEOUS/HOMOGENEOUS--2 x 3 x 6 (MATCHED)

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Esimate	$F_{ratio} = \frac{mS}{mS_w}$	Required	
Grouping A	34.4	1	34.4	$F_A = \frac{34.4}{1.77} = 19.44 \frac{1}{1116}$	.001:11.2	S
Levels B	1061	2	530.5	$F_B = 299.7 \frac{2}{1116}$	.001:7.2	S
Subjects C	56.8	5	11.36	$F_C = 6.42 \frac{5}{1116}$	.001:4.3	S
Interaction						
AB	3.5	2	1.75			NS
AC	19.6	5	3.92	$F_{AC} = 2.21 \frac{5}{1116}$	.05:2.26	NS
BC	13.7	10	1.37			NS
ABC	11.5	10	1.15			NS
Within cells	1976.2	1116	1.77			
Total	3176.7	1151				

were not significant, although that for grouping and subjects was close to the .05 level indicating that there was some variation in achievement by subjects for heterogeneous and homogeneous grouping. For random data the relationships were very similar to those for matched data, except that the interaction between grouping and subjects was significant at the .01 level and emphasized the variation in achievement between these factors. The calculations are shown in Appendix B, Tables XLVIII and XLIX.

TABLE IX

SUMMARY OF ANALYSIS OF VARIANCE FOR DATA OF APPENDIX B TABLE XLIX
HETEROGENEOUS/HOMOGENEOUS--2 x 3 x 6 (RANDOM)

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	$F_{ratio} = \frac{mS}{mS_W}$	df	Required	
Grouping A	69.1	1	69.1	$F_A = \frac{69.1}{2.00} = 34.55$	1/1116	.001:11.2	S
Levels B	1076.2	2	538.1	$F_B = 269.1$	2/1116	.001:7.2	S
Subjects C	36.4	5	7.28	$F_C = 3.64$	5/1116	.01:3.04	S
Interaction							
AB	11.8	2	5.9	$F_{AB} = 2.95$	2/1116	.05:3.00	NS
AC	32.3	5	6.46	$F_{AC} = 3.23$	5/1116	.01:3.04	S
BC	7.7	10	0.77	$F_{BC} = 0.39$	10/1116	.05:1.84	NS
ABC	11.3	10	1.13	$F_{ABC} = 0.57$	10/1116		NS
Within cells	2228.1	1116	2.00				
Total	3472.9	1151					

Analysis of Variance: Two-Way Classification

Since these relationships were highly significant, analyses of variance: two-way classification were carried out for each subject using both types of data. Where significant relationships were indicated, the F-tests were followed by t-tests.

In the analysis of variance tables, the following abbreviations were used:

$\sum_{r=1}^{R} T_r^2$ = the sum of the squares of the totals for each level.

$\sum_{c=1}^{C} T_c^2$ = the sum of the squares of the totals for each column.

$\sum_{r=1}^{R} \sum_{c=1}^{C} T_{rc}^2$ = the sum of the squares of the totals for each cell.

$\sum_{r=1}^{R} \sum_{c=1}^{C} \sum_{i=1}^{i} X_{rci}^2$ = the sum of the squares of each stanine score in all the cells (6).

T^2 = the square of the sum of all the stanine scores.

N = the number of stanine scores (192).

Analysis of Variance: Two-Way Classification--Reading

Tables X and XI respectively summarize the analysis of variance for matched and random data on reading. In both cases the relationship between achievement in reading and ability levels was significant at well beyond the .01 level. There was no significant difference for the two methods of grouping. There was no significant interaction between levels and method of grouping.

Since there was no significant difference for grouping, t-tests were not necessary.

TABLE X

SUMMARY OF ANALYSIS OF VARIANCE: READING (MATCHED)
HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	$F = \frac{ms}{ms_w}$	df	Required	
Rows (levels)	179.5	2	89.75	F_r=52.49	2/186	.01:4.72	S
Columns (grouping)	1.8	1	1.8	F_c= 1.05	1/186	.05:3.90	NS
Interactions	0.6	2	0.3	F_i= 0.18	2/186	.05:3.05	NS
Within cells	317.3	186	1.71				
Total	499.2	191					

TABLE XI

SUMMARY OF ANALYSIS OF VARIANCE: READING (RANDOM)
HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	$F = \frac{mS}{mS_w}$	df	Required	
Rows (levels)	180.6	2	90.3	F_r=47.03	2/186	.01:4.72	S
Columns (grouping)	0.5	1	0.5	F_c= 0.26	1/186	.05:3.90	NS
Interaction	1.1	2	0.55	F_i= 0.29	2/186	.05:3.05	NS
Within cells	357.8	186	1.92				
Total	540	191					

Analysis of Variance: Two-Way Classification--Literature

Tables XII and XIII respectively summarize the analysis of variance for matched and random data on literature. Findings were the same as those for reading.

TABLE XII

SUMMARY OF ANALYSIS OF VARIANCE: LITERATURE (MATCHED) HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	$F = \frac{mS}{mS_w}$	df	Required	
Rows (levels)	254.9	2	127.45	F_r=56.15	2/186	.01:4.72	S
Columns (grouping)	0.6	1	0.60	F_c= 0.26	1/186	.05:3.90	NS
Interaction	5.0	2	2.50	F_i= 1.10	2/186	.05:3.05	NS
Within cells	423.1	186	2.27				
Total	683.6	191					

Analysis of Variance: Two-Way Classification--Social Studies

Tables XIV and XV respectively summarize the analysis of variance for matched and random data on social studies. In each case the relationship between achievement in social studies and both ability levels and the two methods of grouping was significant at the .01 level. There was no significant interaction.

t-Tests for the significance of the difference between two means for correlated samples (matched) indicated the difference favoring homogeneous grouping was significant (.02) only at level one.

TABLE XIII

SUMMARY OF ANALYSIS OF VARIANCE: LITERATURE (RANDOM)
HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	$F = \frac{mS}{mS_W}$	df	Required	
Rows (levels)	220.1	2	110.05	F_r=47.64	2/186	.01:4.72	S
Columns (grouping)	0.1	1	0.10	F_c= 0.04	1/186	.05:3.90	NS
Interaction	5.3	2	2.65	F_i= 1.15	2/186	.05:3.05	NS
Within cells	429.9	186	2.31				
Total	655.4	191					

TABLE XIV

SUMMARY OF ANALYSIS OF VARIANCE: SOCIAL STUDIES (MATCHED)
HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	170.4	2	85.2	F_r=56.8[illegible]	2/186	.01:4.72	S
Columns (grouping)	10.6	1	10.6	F_c= 7.07	1/186	.01:6.78	S
Interaction	2.8	2	1.4	F_i= 0.93	2/186	.05:3.05	NS
Within cells	279.7	186	1.50				
Total	463.5	191					

TABLE XV

SUMMARY OF ANALYSIS OF VARIANCE: SOCIAL STUDIES (RANDOM) HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	153.2	2	126.6	F_r=68.43	$\frac{2}{186}$	.01:4.72	S
Columns (grouping)	19.4	1	19.4	F_c=10.49	$\frac{1}{186}$	.01:6.78	S
Interaction	2.3	2	1.15	F_i= 0.62	$\frac{2}{186}$	.05:3.05	NS
Within cells	343.7	186	1.85				
Total	518.6	191					

Similarly, t-tests for the significance of the difference between means for independent samples (random) showed the difference favoring homogeneous grouping significant at the .01 level for ability level one.

Tables XXII and XXIII, page 61, summarize the results of t-tests for matched and random data respectively.

Analysis of Variance: Two-Way Classification--Language

Tables XVI and XVII respectively summarize the analysis of variance for matched and random data on language. The difference in achievement at the three ability levels was significant at well beyond the .01 level. There was no significant interaction. For random data the difference between methods of grouping was significant at the .02 level; for matched the difference was not quite significant at the .05 level.

t-Tests for the significance of the difference between two means

TABLE XVI

SUMMARY OF ANALYSIS OF VARIANCE: LANGUAGE (MATCHED)
HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	154.0	2	77.0	F_r=40.53	$\frac{2}{186}$	.01:4.72	S
Columns (grouping)	6.4	1	6.4	F_c= 3.37	$\frac{1}{186}$	.05:3.90	NS
Interaction	2.8	2	1.4	F_i= 0.74	$\frac{2}{186}$	.05:3.05	NS
Within cells	353.2	186	1.90				
Total	516.4	191					

TABLE XVII

SUMMARY OF ANALYSIS OF VARIANCE: LANGUAGE (RANDOM)
HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	168.8	2	84.4	F_r=41.99	$\frac{2}{186}$	.01:4.72	S
Columns (grouping)	13.0	1	13.0	F_c= 6.47	$\frac{1}{186}$	.01:6.78	S(.02)
Interaction	6.2	2	3.1	F_i= 1.54	$\frac{2}{186}$	.05:3.05	NS
Within cells	373.8	186	2.01				
Total	561.8	191					

for correlated samples (matched) indicated the difference favoring homogeneous grouping was not quite significant at the .05 level for level one. Differences at levels two and three were not significant.

t-Tests for random data showed significant differences at level one (.02) and at level three (.05). Both favored homogeneous grouping. At level two the difference was not significant.

A summary of the calculations for the t-tests is shown in Tables XXII and XXIII, page 61.

Analysis of Variance: Two-Way Classification--Mathematics

Tables XVIII and XIX respectively summarize the analysis of variance for matched and random data on mathematics. In each case the relationship between achievement in mathematics and both ability levels and the two methods of grouping was significant at well beyond the .01 level. There was no significant interaction.

t-Tests applied to matched pairs data and to random data indicated the difference favoring homogeneous grouping was significant at the .01 level for both levels one and three. For level two the difference was not significant. Summaries of both calculations are shown in Tables XXII and XXIII.

Analysis of Variance: Two-Way Classification--Science

Tables XX and XXI respectively summarize the analysis for matched and random data on science. For both, the relationship between achievement and levels was significant at well beyond the .01 level. For matched pairs in grouping the relationship favoring homogeneous grouping was significant at the .034 level; for random data, at the .01 level.

TABLE XVIII

SUMMARY OF ANALYSIS OF VARIANCE: MATHEMATICS (MATCHED)
HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	179.3	2	89.65	F_r=52.74	$\frac{2}{186}$	.01:4.72	S
Columns (grouping)	26.3	1	26.30	F_c=15.48	$\frac{1}{186}$	.01:6.78	S
Interaction	3.1	2	1.55	F_i= 0.91	$\frac{2}{186}$	.05:3.05	NS
Within cells	315.7	186	1.70				
Total	524.4	191					

TABLE XIX

SUMMARY OF ANALYSIS OF VARIANCE: MATHEMATICS (RANDOM)
HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	207.6	2	103.8	F_r=51.9	$\frac{2}{186}$	.01:4.72	S
Columns (grouping)	49.0	1	49.0	F_c=24.5	$\frac{2}{186}$	.01:6.78	S
Interaction	6.3	2	3.15	F_i= 1.58	$\frac{2}{186}$	.05:3.05	NS
Within cells	372.6	186	2.00				
Total	635.5	191					

TABLE XX

SUMMARY OF ANALYSIS OF VARIANCE: SCIENCE (MATCHED)
HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	136.6	2	68.3	F_r=41.04	2/186	.01:4.72	S
Columns (grouping)	8.3	1	8.3	F_c= 5.06	1/186	.05:3.90	S
Interaction	0.6	2	0.3	F_i= 0.18	2/186	.05:3.05	NS
Within cells	305.3	186	1.64				
Total	450.8	191					

TABLE XXI

SUMMARY OF ANALYSIS OF VARIANCE: SCIENCE (RANDOM)
HETEROGENEOUS/HOMOGENEOUS--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	153.5	2	76.75	F_r=40.82	2/186	.01:4.72	S
Columns (grouping)	19.4	1	19.40	F_c=10.32	1/186	.01:6.78	S
Interaction	2.0	2	1.00	F_i= 0.53	2/186	.05:3.05	NS
Within cells	350.3	186	1.88				
Total	525.2	191					

TABLE XXII

SUMMARY OF SIGNIFICANCE OF THE DIFFERENCE BETWEEN TWO MEANS FOR CORRELATED SAMPLES (MATCHED PAIRS)

Subject	Level	Hetero $\bar{X}$	Homo $\bar{X}$	$\sum D$	$\bar{D}$	$\sum D^2$	S_D^2	t df=31	.05:2.039 .01:2.745
Social	1	6.938	7.719	25	.781	105	2.671	2.66	S(.02)
Studies	2	6.281	6.469	6	.188	82	2.528	0.66	NS
	3	4.813	5.250	14	.437	76	2.184	1.65	NS
Language	1	6.531	7.219	22	.688	130	3.590	2.02	not quite S
	2	6.063	6.375	10	.313	84	2.527	1.10	NS
	3	4.688	4.783	3	.095	67	2.085	0.37	NS
Mathe-	1	6.344	7.125	25	.781	77	1.796	3.24	S(.01)
matics	2	5.813	6.219	13	.406	59	1.679	1.74	NS
	3	3.906	4.938	33	1.032	163	4.029	2.86	S(.01)
Science	1	7.000	7.375	12	.375	78	2.297	1.38	NS
	2	6.219	6.781	18	.562	92	2.559	1.96 not quite	S
	3	5.000	5.313	10	.313	116	3.527	0.93	NS

TABLE XXIII

SUMMARY OF SIGNIFICANCE OF THE DIFFERENCE BETWEEN TWO MEANS FOR INDEPENDENT SAMPLES (RANDOM DATA)

Subject	Level	Hetero $\bar{X}$	Homo $\sum(X-\bar{X})^2$	Homo $\bar{X}$	Homo $\sum(X-\bar{X})^2$	S^2	t df=62	.05:2.000 .01:2.659
Social	1	6.656	61.219	7.594	51.719	1.822	2.78	S(.01)
Studies	2	5.813	61.018	6.344	55.219	1.875	1.55	NS
	3	4.719	62.469	5.156	48.775	1.794	1.30	NS
Language	1	6.688	66.875	7.563	53.875	1.948	2.51	S(.02)
	2	5.938	65.875	5.969	66.969	2.143	0.08	NS
	3	4.500	46.000	5.156	54.219	1.616	2.06	S(.05)
Mathe-	1	6.375	47.500	7.656	45.219	1.495	4.19	S(.01+)
matics	2	5.531	63.969	6.031	62.969	2.047	1.40	NS
	3	3.844	72.219	5.094	80.719	2.467	3.18	S(.01+)
Science	1	6.813	40.875	7.719	46.369	1.469	3.05	S(.01)
	2	5.875	71.500	6.281	62.469	2.161	1.10	NS
	3	4.781	75.469	5.375	53.500	2.080	1.65	NS

Interaction was not significant.

t-Tests for matched pairs showed no significant difference at any level, although level two was close to the .05 level. t-Tests applied to random data showed a significant difference (.01) at level one but not for levels two and three. The calculations are summarized in Tables XXII and XXIII.

Summary of Analysis: 2 x 3 x 6

The findings for the analysis involving the six subjects and two methods of grouping are summarized in Table XXIV. The over-all analysis of variance indicated a difference, significant at the .001 level, favoring homogeneous over heterogeneous grouping. The difference was significant at the .01 level for both social studies and mathematics. The differences for science and language were significant (matched) at the .05 and not quite .05 levels respectively; (random) at the .01 and .02 levels respectively. Differences in achievement by levels were significant at .001 level. There were no significant differences for reading and literature. In all cases differences in means favored homogeneous grouping over heterogeneous.

Table XXII summarizes the t-tests (matched) for social studies, language, mathematics and science. Differences between means were significant only at level one (social studies) and levels one and three (mathematics). Differences were almost significant at level one (language) and level two (science).

Table XXIII summarizes the t-tests (random) for the same four subjects. At level one differences in means for social studies, mathematics and science were significant at the .01 level, for language at the

TABLE XXIV

SUMMARY OF ANALYSIS OF DATA: HETEROGENEOUS/HOMOGENEOUS--2 x 3 x 6

ANALYSES	MATCHED PAIRS DATA	RANDOM DATA
Analysis of Variance:	Homogeneous superior (.001)	Homogeneous superior (.001)
Three-way classification	Subject achievement diff (.001)	Subject achievement diff (.001)
2 methods	Interaction:	Interaction:
3 levels	Grouping x Subjects NSD	Grouping x Subjects SD (.01)
6 subjects	Other interactions: NSD	Other interactions: NSD
Analysis of Variance:	Interaction: NSD for any subject between method of grouping and ability levels	
2-way classification		
Reading	NSD	NSD
Literature	NSD	NSD
Social Studies	SD .01 level	SD .01 level
t-tests Level 1	SD .02	SD .01
Levels 2,3	NSD	NSD
Language	Not quite .05	SD .02
t-tests Level 1	Not quite .05	SD .02
Level 2	NSD	NSD
Level 3	NSD	SD .05
Mathematics	SD well beyond .01	SD well beyond .01
t-tests Level 1	SD .01	SD .01
Level 2	NSD	NSD
Level 3	SD .01	SD .01
Science	SD .05	SD .01
t-tests Level 1	NSD	SD .01
Level 2	Not quite .05	NSD
Level 3	NSD	NSD

In all cases differences in means favored homogeneous grouping over heterogeneous. In all analyses, achievement by the three ability levels was significantly different at well beyond the .01 level. NSD: no significant difference; SD: significant difference.

.02 level. For level three differences were significant in language (.05) and in mathematics (.01+).

All significant differences indicated by t-tests favored homogeneous grouping.

II. ANALYSIS OF VARIANCE: HETEROGENEOUS/HOMOGENEOUS/SUBJECT GROUPING

Analysis of Variance: Three-Way Classification--3 x 3 x 3

This analysis, carried out on both matched and random data, investigated relationships between three methods of grouping (heterogeneous, homogeneous and subject grouping), three ability levels and three subjects (language, mathematics and science). The blocks (A) represent methods, the rows (B) levels, and the columns (C) subjects.

Tables XXV and XXVI summarize the analysis for matched and random data respectively. For matched data the relationship between achievement and both grouping and ability levels was significant at the .01 level; subjects at the .035 level. All interactions were not significant, except for grouping x subjects which was significant at the .01 level. Findings for random data were the same except that for subjects, significance was at the .05 level.

The calculations are shown in Appendix C (Tables L and LI).

Analysis of Variance: Two-Way Classification--3 x 3; 2 x 3

Since a significant relationship for grouping was found in the three-way classification, further analysis of variance--three methods on three levels--was carried out for language, mathematics and science. This was followed by analyses comparing achievement in the three subjects under homogeneous and subject grouping.

TABLE XXV

SUMMARY OF ANALYSIS OF VARIANCE FOR DATA OF APPENDIX C (TABLE L)
MATCHED PAIRS: 3 x 3 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio} $\frac{mS}{mS_w}$	df	Required	
Grouping A	69.2	2	34.6	F_A=18.99	$\frac{2}{837}$	.01:4.63	S
Levels B	702.0	2	351.0	F_B=192.6	$\frac{2}{837}$	.01:4.63	S
Subjects C	13.2	2	6.6	F_C= 3.62	$\frac{2}{837}$	.05:3.00	S(.035)
Interaction							
AB	13.9	4	3.48	F_{AB}= 1.91	$\frac{4}{837}$	.05:2.38	NS
AC	41.1	4	10.28	F_{AC}= 5.64	$\frac{4}{837}$	.01:3.34	S
BC	2.2	4	0.55	F_{BC}			NS
ABC	6.4	8	0.80	F_{ABC}			NS
Within cells	1524.7	837	1.822				
Total	2372.7	863					

t-Tests were then run to determine more closely the location of differences.

Language

Tables XXVII and XXVIII respectively summarize the analysis (3 x 3) for matched and random data on language. For each there was a significant (.01) relationship between achievement in language and both ability levels and methods of grouping. Interaction was not significant.

Tables XXIX and XXX summarize the analysis for homogeneous/subject grouping. For both the relationship for levels was significant (.01); for interaction not significant. Matched data indicated a significant

TABLE XXVI

SUMMARY OF ANALYSIS OF VARIANCE FOR DATA OF APPENDIX C (TABLE LI)
RANDOM: 3 x 3 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio} $\frac{mS}{mS_w}$	df	Required	
Grouping A	94.7	2	47.35	F_A=22.99	$\frac{2}{837}$	.01:4.63	S
Levels B	765.7	2	382.85	F_B=185.9	$\frac{2}{837}$	.01:4.63	S
Subjects C	12.9	2	6.45	F_C= 3.13	$\frac{2}{837}$	.05:3.00	S
Interaction AB	14.9	4	3.73	F_{AB}= 1.81	$\frac{4}{837}$	.05:2.38	NS
AC	29.4	4	7.35	F_{AC}= 3.57	$\frac{4}{837}$	.01:3.34	S
BC	4.1	4	1.03	F_{BC}			NS
ABC	5.7	8	0.71	F_{ABC}			NS
Within cells	1724.3	837	2.06				
Total	2651.7	863					

TABLE XXVII

SUMMARY OF ANALYSIS OF VARIANCE: LANGUAGE (MATCHED) HETEROGENEOUS/HOMOGENEOUS/SUBJECT GROUPING--3 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	241	2	120.5	F_r=63.76	$\frac{2}{279}$	.01:4.69	S
Columns (grouping)	44.9	2	22.45	F_c=11.88	$\frac{2}{279}$	.01:4.69	S
Interaction	9.7	4	2.43	F_i= 1.29	$\frac{4}{279}$	.05:2.40	NS
Within cells	526.7	279	1.89				
Total	822.3	287					

TABLE XXVIII

SUMMARY OF ANALYSIS OF VARIANCE: LANGUAGE (RANDOM) HETEROGENEOUS/HOMOGENEOUS/SUBJECT GROUPING--3 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	264.3	2	132.2	F_r=62.9	$\frac{2}{279}$	.01:4.69	S
Columns (grouping)	42.4	2	21.2	F_c=10.1	$\frac{2}{279}$	.01:4.69	S
Interaction	8.2	4	2.05	F_i= 0.98	$\frac{4}{279}$	.05:2.40	NS
Within cells	586.2	279	2.10				
Total	901.1	287					

TABLE XXIX

SUMMARY OF ANALYSIS OF VARIANCE: LANGUAGE (MATCHED)
HOMOGENEOUS/SUBJECT GROUPING--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	187.9	2	94.0	F_r=50.00	2/186	.01:4.72	S
Columns (grouping)	16.9	1	16.9	F_c= 8.99	1/186	.01:6.78	S
Interaction	4.0	2	2.0	F_i= 1.06	2/186	.05:3.05	NS
Within cells	350.0	186	1.88				
Total	558.8	191					

TABLE XXX

SUMMARY OF ANALYSIS OF VARIANCE: LANGUAGE (RANDOM)
HOMOGENEOUS/SUBJECT GROUPING--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	187.7	2	93.9	F_r=42.88	2/186	.01:4.72	S
Columns (grouping)	8.3	1	8.3	F_c= 3.79	1/186	.05:3.90	NQS
Interaction	5.8	2	2.9	F_i= 1.32	2/186	.05:3.05	NS
Within cells	407.4	186	2.19				
Total	609.2	191					

difference (.01) for grouping; random not quite .05.

The t-tests for language are summarized in Tables XXXIX and XL on page 76. Differences in means between heterogeneous and homogeneous grouping varied for matched and random data. For the former, differences were not significant for levels two and three, and almost (.05) significant for level one. For the latter differences were significant at level one (.02) and level three (.05) but not at level two.

Greater differences were found in the comparison of heterogeneous with subject grouping. For matched pairs, differences were significant at levels one (.001) and three (.01); for random data at levels one (.01), two (.01), and three (.05).

The comparison between homogeneous and subject grouping showed significant differences for matched at levels one (.02) and three (.01). Random data showed a significant difference (.02) only at level two.

Mathematics

Tables XXXI and XXXII respectively summarize the analysis for matched and random data on mathematics. For both the relationship between achievement and ability levels was significant at the .001 level; grouping at well beyond the .01 level. There was no significant interaction.

Tables XXXIII and XXXIV summarize the analysis for homogeneous/subject grouping. For both types of data the relationship for levels was significant (.01); for grouping and interaction not significant.

t-Tests (matched pairs) indicated significant differences (level one--.01; level three--.01) for homogeneous over heterogeneous grouping.

TABLE XXXI

SUMMARY OF ANALYSIS OF VARIANCE: MATHEMATICS (MATCHED)
HETEROGENEOUS/HOMOGENEOUS/SUBJECT GROUPING--3 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	261.4	2	130.7	F_r=72.61	2/279	.01:4.69	S
Columns (grouping)	54.2	2	27.1	F_c=15.06	2/279	.01:4.69	S
Interaction	6.8	4	1.7	F_i= 0.94	4/279	.05:2.40	NS
Within cells	502.7	279	1.80				
Total	825.1	287					

TABLE XXXII

SUMMARY OF ANALYSIS OF VARIANCE: MATHEMATICS (RANDOM)
HETEROGENEOUS/HOMOGENEOUS/SUBJECT GROUPING--3 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	295.1	2	147.6	F_r=67.07	2/279	.01:4.69	S
Columns (grouping)	61.0	2	30.5	F_c=13.86	2/279	.01:4.69	S
Interaction	7.1	4	1.78	F_i= 0.81	4/279	.05:2.40	NS
Within cells	614.9	279	2.20				
Total	978.1	287					

TABLE XXXIII

SUMMARY OF ANALYSIS OF VARIANCE: MATHEMATICS (MATCHED)
HOMOGENEOUS/SUBJECT GROUPING--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	162.2	2	81.2	F_r=46.40	$\frac{2}{186}$	.01:4.72	S
Columns (grouping)	4.1	1	4.1	F_c = 2.34	$\frac{1}{186}$	.05:3.90	NS
Interaction	0.8	2	0.4	F_i= 0.23	$\frac{2}{186}$	.05:3.05	NS
Within cells	325.9	186	1.75				
Total	493.0	191					

TABLE XXXIV

SUMMARY OF ANALYSIS OF VARIANCE: MATHEMATICS (RANDOM)
HOMOGENEOUS/SUBJECT GROUPING--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	195.1	2	97.6	F_r=42.07	$\frac{2}{186}$	.01:4.72	S
Columns (grouping)	0.3	1	0.3	F_c= 0.13	$\frac{1}{186}$	.05:3.90	NS
Interaction	0.8	2	0.4	F_i= 0.17	$\frac{2}{186}$	.05:3.05	NS
Within cells	431.2	186	2.32				
Total	627.4	191					

Random data showed similar differences (.001 and .01). Differences between heterogeneous and subject grouping favored the latter; for matched pairs at levels one, two, and three, respectively, .001, .05, and .01; for random data at levels one and three, .01, and .01. Differences between homogeneous and subject grouping were not significant.

Summaries of t-tests for mathematics are included in Tables XXXIX and XL, page 76 .

Science

Tables XXXV and XXXVI respectively summarize the analysis of variance (3 x 3) for matched and random data on science. For both, the relationship between levels and achievement was significant (.01). The relationship for grouping was significant (matched--.05 and random--.01). Interaction was significant (.01) for random data but not for matched pairs.

Tables XXXVII and XXXVIII summarize the analysis for homogeneous/subject grouping. For both types of data the relationship between levels was significant (.01); between grouping methods better than .05 favoring homogeneous. Interaction was not significant.

The only significant differences between means for matched pairs were at level two in favor of homogeneous over subject grouping (.01) and at level two (not quite .05) for homogeneous grouping over heterogeneous.

For random data, t-tests indicated significant differences (.01) only at level one for homogeneous grouping over both heterogeneous and subject grouping.

TABLE XXXV

SUMMARY OF ANALYSIS OF VARIANCE: SCIENCE (MATCHED)
HETEROGENEOUS/HOMOGENEOUS/SUBJECT GROUPING--3 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	201.9	2	100.95	F_r=57.03	2/279	.01:4.69	S
Columns (grouping)	11.1	2	5.55	F_c= 3.14	2/279	.05:3.01	S
Interaction	3.9	4	0.98	F_i= 0.55	4/279	.05:2.40	NS
Within cells	495.2	279	1.77				
Total	712.1	287					

TABLE XXXVI

SUMMARY OF ANALYSIS OF VARIANCE: SCIENCE (RANDOM)
HETEROGENEOUS/HOMOGENEOUS/SUBJECT GROUPING--3 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	170	2	85.0	F_r=45.21	2/279	.01:4.69	S
Columns (grouping)	20.9	2	10.45	F_c= 5.56	2/279	.01:4.69	S
Interaction	41.6	4	10.4	F_i= 5.53	4/279	.01:3.39	S
Within cells	532.2	279	1.88				
Total	759.7	287					

TABLE XXXVII

SUMMARY OF ANALYSIS OF VARIANCE: SCIENCE (MATCHED)
HOMOGENEOUS/SUBJECT GROUPING--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	137.0	2	68.50	F_r=38.48	$\frac{2}{186}$	.01:4.72	S
Columns (grouping)	8.3	1	8.30	F_c= 4.66	$\frac{1}{186}$	.05:3.90	S(.04)
Interaction	3.8	2	1.90	F_i= 1.07	$\frac{2}{186}$	.05:3.05	NS
Within cells	331.7	186	1.78				
Total	480.8	191					

TABLE XXXVIII

SUMMARY OF ANALYSIS OF VARIANCE: SCIENCE (RANDOM)
HOMOGENEOUS/SUBJECT GROUPING--2 x 3

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F_{ratio}	df	Required	
Rows (levels)	144.5	2	72.25	F_r=40.14	$\frac{2}{186}$	.01:4.72	S
Columns (grouping)	10.6	1	10.6	F_c= 5.89	$\frac{1}{186}$	.05:3.90	S(.022)
Interaction	4.9	2	2.45	F_i= 1.36	$\frac{2}{186}$	.05:3.05	NS
Within cells	335.4	186	1.80				
Total	495.4	191					

All homogeneous means were superior to those for both heterogeneous and subject grouping. Tables XXXIX and XL contain the summaries of these t-tests.

Summary of Analysis: 3 x 3 x 3

The findings of the analysis on language, mathematics and science for the three methods of grouping are summarized in Table XLI, page 79. The over-all analysis of variance indicated differences, significant at well beyond the .01 level for the three methods of grouping. The separate subject analyses of variance indicated differences significant at the .01 level, except for science (matched) which was significant only at the .05 level. Analysis of variance (language) indicated a significant difference (.01--matched and not quite .05--random) for subject grouping over homogeneous. Analysis of variance (mathematics) indicated no significant difference between subject grouping and homogeneous. For science the significant difference (.04 and .022) favored homogeneous over subject grouping.

Table XXXIX summarizes the t-tests (matched) in language, mathematics and science for heterogeneous/subject grouping and homogeneous/subject grouping. Table XL summarizes the t-tests for random data. The results are somewhat similar. In both tables, language achievement under subject grouping appears superior to that under heterogeneous grouping. Some superiority in language is indicated for subject grouping over homogeneous. Very significant differences are indicated for subject grouping over heterogeneous in mathematics. There were no significant differences between homogeneous and subject grouping in

TABLE XXXIX

SUMMARY OF SIGNIFICANCE OF THE DIFFERENCE BETWEEN TWO MEANS FOR CORRELATED SAMPLES (MATCHED PAIRS)

Subject	Level	$\underline{A}$ X	$\underline{B}$ X	$\sum D$	$\bar{D}$	$\sum D^2$	S_D^2	t df=31	.05:2.039 .01:2.745
Language	1	6.531	8.000	47	1.469	133	1.998	5.78	S(.001)
Hetero A	2	6.063	6.563	16	.500	88	2.500	1.76	NS
Subj.Gpg B	3	4.688	5.594	29	.906	124	3.054	2.89	S(.01)
Language	1	7.219	8.000	25	.781	115	2.984	2.50	S(.02)
Homo A	2	6.375	6.563	6	.188	94	2.903	0.61	NS
Subj.Gpg B	3	4.783	5.594	26	.811	108	2.717	2.74	S(.01)
Mathematics	1	6.344	7.563	39	1.219	117	2.170	4.60	S(.001)
Hetero A	2	5.813	6.344	17	.531	67	1.812	2.19	S(.05)
Subj.Grpg B	3	3.906	5.250	43	1.344	205	4.600	3.49	S(.01)
Mathematics	1	7.125	7.563	14	.438	80	2.308	1.60	NS
Homo A	2	6.219	6.344	4	.125	54	1.672	0.53	NS
Subj.Gpg B	3	4.938	5.250	10	.312	130	3.965	0.87	NS
Science	1	7.000	7.156	5	.156	67	1.851	0.64	NS
Hetero A	2	6.219	5.969	-8	-.250	76	2.312	0.92	NS
Subj.Gpg B	3	5.000	5.094	3	.094	153	4.772	0.24	NS
Science	1	7.375	7.156	-7	-.219	103	3.171	0.68	NS
Homo A	2	6.781	5.969	-26	-.812	74	1.653	3.52	S(.01)
Subj.Gpg B	3	5.313	5.094	-7	-.219	115	3.546	0.65	NS

TABLE XL

SUMMARY OF SIGNIFICANCE OF THE DIFFERENCE BETWEEN TWO MEANS FOR INDEPENDENT SAMPLES (RANDOM DATA)

Subject	Level	$\underline{A}$ $\bar{X}$	$\sum(X-\bar{X})^2$	$\underline{B}$ $\bar{X}$	$\sum(X-\bar{X})^2$	S^2	t df=62	.05:2.000 .01:2.659
Language	1	6.688	66.875	7.750	56.000	1.982	3.02	S (.01)
Hetero A	2	5.938	65.875	6.875	55.498	1.958	2.68	S (.01)
Subj.Gpg B	3	4.500	46.000	5.313	100.875	2.369	2.11	S (.05)
Language	1	7.563	53.875	7.750	56.000	1.772	0.56	NS
Homo A	2	5.969	66.969	6.875	55.498	1.975	2.58	S (.02)
Subj.Gpg B	3	5.156	54.219	5.313	100.875	2.502	0.40	NS
Mathematics	1	6.375	47.500	7.406	49.719	1.568	3.29	S (.01+)
Hetero A	2	5.531	63.969	6.094	60.719	2.011	1.59	NS
Subj.Gpg B	3	3.844	72.219	5.063	131.875	3.292	2.69	S (.01)
Mathematics	1	7.656	45.219	7.406	49.719	1.531	0.81	NS
Homo A	2	6.031	62.969	6.094	60.719	2.011	0.18	NS
Subj.Gpg B	3	5.094	80.719	5.063	131.875	3.292	0.07	NS
Science	1	6.813	40.875	6.844	46.219	1.405	0.10	NS
Hetero A	2	5.875	71.500	6.188	40.875	1.813	0.93	NS
Subj.Gpg B	3	4.781	75.469	4.938	85.875	2.602	0.39	NS
Science	1	7.719	46.469	6.844	46.219	1.495	2.86	S (.01)
Homo A	2	6.281	62.469	6.188	40.875	1.667	0.29	NS
Subj.Gpg B	3	5.375	53.500	4.938	85.875	2.248	1.17	NS

mathematics. In science the only significant differences favored homogeneous over subject grouping (level two, matched--.01 and level one, random--.01).

TABLE XLI

SUMMARY OF ANALYSIS OF DATA: HETEROGENEOUS/HOMOGENEOUS/SUBJECT GROUPING

Analysis of Variance 3x3x3		Matched Pairs			Random Data		
Subject achievement		S .035			S .05		
Grouping Achievement		S .01+			S .01+		
Levels		S .001			S .001		
Interaction: Group. x Subj.		S .01			S .01		
All other interactions		NS			NS		
Analysis of Variance 3x3		Language		Mathematics		Science	
		Matched	Random	Matched	Random	Matched	Random
Grouping		S .01	S .01	S .01	S .01	S .05	S .01
Levels		S .01	S .01	S .01	S .01	S .01	S .01
Interaction:Group/Levels		NS	NS	NS	NS	NS	NS
Analysis of Variance 2x3 Homogeneous/Subj.Grouping							
Grouping		S .01	NS .05-	NS	NS	S .04	S .022
Levels		S .01	S .01	S .01	S .01	S .01	S .01
Interaction:Group/Levels		NS	NS	NS	NS	NS	NS
t-Tests							
Heter/Homo:	Level 1	NS .05-	S .02	S .01	S .01	NS	S .01
	Level 2	NS	NS	NS	NS	NS .05-	NS
	Level 3	NS	S .05	S .01	S .01	NS	NS
Heter/Subj.Grouping	Level 1	S .001	S .01	S .001	S .01	NS	NS
	Level 2	NS	S .01	S .05	NS	NS	NS
	Level 3	S .01	S .05	S .01	S .01	NS	NS
Homo/Subj.Grouping	Level 1	S.05	NS	NS	NS	NS	S..01*
	Level 2	NS	S.02	NS	NS	S..01*	NS
	Level 3	S .01	NS	NS	NS	NS	NS

In t-tests all significant differences favored the method on the right, except *. For language and mathematics all differences in means favored the method on the right. Homogeneous means were highest at all levels in science.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

I. SUMMARY OF THE FINDINGS

The major findings of this study are given for each of the variables or factors examined.

Ability Levels

Significant differences in the means of pupil stanine achievement were found for the three ability levels in all six subjects. The means were in rank order of ability.

Methods of Grouping

1. Heterogeneous/Homogeneous

There was a significant difference in the achievement of Parkview grade nine pupils on departmental examinations, stanine scores under homogeneous grouping being superior to those under heterogeneous grouping.

There was a significant difference in achievement among the six departmental subjects; F-tests indicated that pupils did better in homogeneous classes in social studies, language, mathematics and science. For reading and literature no significant differences were indicated.

In reading all differences in means (matched data) favored homogeneous grouping. Random data showed the homogeneous mean superior (.313 stanines) at level two but little difference at levels one and

three.

In literature matched data indicated slight superiority for homogeneous grouping at levels one and two, but a mean .562 stanines lower at level three. Random data indicated superiority for homogeneous grouping at levels one and three, the reverse at level two. However, the combined difference in means was small.

A significant difference favoring homogeneous grouping was found in social studies. The difference was significant only at level one, but the general tendency favored homogeneous grouping at levels two and three.

Matched data indicated that the difference in language achievement under the two grouping methods was not quite significant at the .05 level. Differences between means at all levels favored homogeneous grouping. Using the random data, levels one and three showed a significant difference favoring homogeneous achievement. Level two showed a slight similar tendency.

Both types of data showed a significant difference (.01) favoring homogeneous grouping in mathematics achievement at levels one and three. A similar tendency was evident for level two.

In science the analysis of variance for matched data indicated a significant difference (.05 level) favoring homogeneous grouping but t-tests showed no significant difference. However, using random data level one showed a significant difference (.01 level) favoring homogeneous grouping. All differences in means supported this tendency.

In summary, F-tests indicated that general achievement in social studies, language, mathematics and science under homogeneous grouping was significantly superior to that under heterogeneous grouping.

Differences for reading and literature were not significant. t-Tests indicated that significant differences were located primarily at level one and then at level three. There were no significant differences at level two for any subject. All differences in means for social studies, language, mathematics and science supported the inference of superiority for homogeneous grouping. Differences in means for reading and literature were inconsistent.

2. Heterogeneous/Homogeneous/Subject Grouping

There was a significant difference in the achievement of Parkview grade nine pupils on departmental examinations for language, mathematics and science under the three methods of grouping.

There was a significant difference in achievement among the three departmental subjects.

Achievement among the three subjects varied with the methods of grouping.

F-tests indicated that subject-grouped pupils in language did better than those in homogeneous classes, significant (matched) at the .01 level and (random) not quite .05. In mathematics F-ratios for these two methods showed no significant difference. In science, homogeneous classes did better than those subject-grouped, significant (matched) at the .04 level and (random) at the .022 level.

In language, random data for levels one and three showed a significant difference for homogeneous grouping over heterogeneous. All differences in means favored homogeneous over heterogeneous grouping. There was a significant difference in matched data at levels one and three favoring subject grouping over heterogeneous. A similar difference

was found at all levels using random data. Subject grouping was significantly superior to homogeneous at levels one and three (matched data) and level two (random data). Superiority in means was .594 stanines (matched) and .417 stanines (random). All differences in means rated subject grouping first, homogeneous, second, and heterogeneous, third.

In mathematics both matched and random data indicated a significant difference favoring homogeneous grouping over heterogeneous at levels one and three. Matched data showed a significant difference favoring subject grouping over heterogeneous at all three levels. Random data showed a similar difference at levels one and three. All differences in means for matched data rated subject grouping first, homogeneous second, and heterogeneous third. There were, however, no significant differences between subject grouping and homogeneous. Differences in means at levels one and three for random data favored homogeneous over subject grouping.

In science, results were inconsistent with those in language and mathematics. The analysis of variance for matched data indicated a significant difference (.05 level) favoring homogeneous grouping over heterogeneous but t-tests showed no significant difference. A similar difference significant at the .01 level was found using random data, t-tests showing significance only at level one. All differences in means indicated a general tendency for homogeneous superiority over heterogeneous grouping. There were no significant differences between subject grouping and heterogeneous but subject grouping means were superior to heterogeneous except for level two (matched data). Significant differences favored homogeneous grouping over subject grouping at level two

(matched data) and level one (random data). Homogeneous means were superior to subject grouping means at all levels.

In summary, significant differences for language indicated that subject grouping, homogeneous and then heterogeneous grouping were to be preferred in that order. In mathematics significant differences indicated a superiority for both homogeneous and subject grouping over heterogeneous. Differences in means between homogeneous and subject grouping for matched and random data were inconsistent. In science homogeneous grouping was the most effective. Differences between the other two methods were inconsistent.

II. SOME CONCLUSIONS AND IMPLICATIONS

The results of the analysis of pupil achievement comparing heterogeneous and homogeneous grouping provided fairly conclusive evidence in favor of the latter. In social studies, language, mathematics and science all significant differences and all differences in means supported the inference and suggested that in general there may be certain advantages deriving from homogeneous grouping in these subjects. The greatest advantage was evident in mathematics where the starting achievement level was lowest, and at levels one and three where all significant differences were evident. Differences at level two were high enough to indicate a general tendency of superiority for homogeneous grouping.

Results for literature were inconsistent with the general tendency and differed for matched and random data. Any inference would be highly tentative since there were no significant differences and the over-all

difference in means was slight. The fact that the starting literature achievement mean was the highest for all subjects may have affected the results.

Since reading was not scheduled as a regular subject, the results are only of academic interest. There were no significant differences and all means were higher under homogeneous grouping except level one (random data). The tendency (if any) favoring homogeneous grouping was reversed by analysis of the last two years of the study.

Since reading and literature are similar in certain respects, we might conclude from this study that there was little difference in achievement under homogeneous or heterogeneous grouping. Unless starting achievement levels are low, it might be just as well to utilize heterogeneous grouping if other factors require consideration.

The general inference that subject grouping would produce higher academic achievement was not statistically borne out in this study. For language there was some statistical evidence and a general tendency supporting the superiority of subject grouping over homogeneous grouping. The difference in stanine means--.417 matched and .594 random--would suggest utilization of the former for maximum positive results especially if present language achievement is relatively low.

In mathematics there were no significant differences between subject grouping achievement and homogeneous. No general tendency was evident since matched data showed the subject grouping means higher by .291 stanines and random data lower by .072 stanines. In any case the evidence would not appear to warrant the extra work entailed in organizational difficulties unless the teaching staff saw in subject grouping

certain inherent advantages for teaching methods.

In science any general tendency would appear to favor homogeneous grouping over subject grouping. Homogeneous means (matched) were .417 stanines higher, (random) were .468 stanines higher. This significant difference is high enough to suggest that for science homogeneous grouping should be preferred to subject grouping. There has been some suggestion that the 1964 Science examination differed in some respects from preceding ones. Any inferences therefore must be highly tentative.

III. RECOMMENDATIONS

In an educational study of this type the question of assigning cause tends to make all conclusions tentative. The number of factors, teacher qualifications, length and type of experience, class size, motivation, to mention a few, is large. Their strength and influence may well vary over a period of years. Many of them cannot be controlled, except possibly in experimental schools where special steps may be taken for the purpose of research. The reader does not need to be reminded of the variability in general and special abilities of student populations from year to year. In this study, while homogeneous and subject grouping samples were similar to the control group sample (heterogeneous) in the selected characteristics, the question of variability still remains.

The question as to whether homogeneous or subject grouping as forms of organization facilitate teaching methods and techniques so as to have a beneficial effect on academic achievement may not be proven conclusively. Yet, for this particular school there would appear to be sufficient evidence to warrant the utilization of homogeneous grouping in

social studies, language, mathematics and science. If there are benefits arising from pupils of all ability levels working in a classroom situation then it would appear that literature could be grouped heterogeneously with little difference in academic achievement.

For language and to a lesser extent for mathematics the evidence strongly suggests that subject grouping may have a more positive effect on achievement than homogeneous grouping. If timetabling permits it, students might well benefit from this form of class organization.

While this study was concerned with only one school, one might judge that in similar schools in similar socio-economic areas these forms of class organization would tend to be equally effective. No inference can be made with regard to large junior high schools in different socio-economic areas, or to lower grade levels. It is suggested tha other schools might find some benefit by instituting subject-grouping in a low achievement subject and comparing achievement means to discover how effective it is in their circumstances. It can be one way of raising the level of aspiration and of increasing motivation.

Homogeneous grouping seemed to produce greater pupil effort. The element of competition and the strong desire of many parents for their children to achieve level one or at least a level in line with the individual's innate ability was probably a factor in this respect.[1]

The fact that homogeneous grouping showed positive effects at all levels for the four subjects is worthy of note, since it would indicate that there was no academic loss at any level. Care, however, should be

---

[1]Comments by a number of parents to the writer indicated their support of grouping as an incentive to greater effort.

taken at level three to encourage pupils by the use of a simplified approach to the regular curriculum. Subject grouping has one advantage for pupil morale in that a low student may not be in the bottom group for all subjects. In this sense it provides for individual differences in subject achievement. Any success in achievement is important to the bottom group.

IV. RECOMMENDATIONS FOR FUTURE STUDY

The search for truth and the continuing quest for more effective methods of teaching and learning suggest a need for further studies in the field of class organization. As research in the fields of educational psychology and educational sociology widens our body of knowledge, new factors in the learning processes of individuals or groups will become evident. Their effects will almost certainly invalidate some previous research and raise questions which need to be solved.

A major weakness in previous research on grouping seems to have been the assumption that it might produce a blanket effect across all grade levels, in all subjects and in all ability areas. The mass of conflicting results have negated this expectation. The need for consideration of all pertinent factors in achievement in order to assign cause is confused by the fact that many such factors have not been assessed at all grade levels and in all subjects. Future research in grouping must await such findings, or arrange for their control.

Answers to certain questions are still needed. Will any form of grouping be effective unless the level of aspiration is raised? Would "cluster" grouping relieve the lack of vitality in a low-level homogeneous

class? If subject grouping is carried out in only one subject, is it generally effective in raising academic achievement in that subject? Is the positive effect of subject-grouping limited by an inability of students to concentrate effort in more than one field? Does concentration of class effort in one subject tend to lower achievement in any other subject? If an optimum level of achievement is reached in one subject by the use of subject grouping, is this new level of attainment maintained if subject grouping is switched to another subject?

If future studies are undertaken in this complex area, a continuing assessment of possible side effects would provide some concrete evidence in a somewhat empty area of our field of knowledge.

Since what the teacher does in the classroom affects vitally any such research study, it is essential that they be professionally interested and involved in questions as they arise. Without their cooperation and positive orientation, any such study will lack validity.

In the design of any study by levels the outside limits and range of the levels should be set carefully. In this study the effect of placing thirty-two matched pairs in each level was to limit level two to a range of only ten I.Q. points. Differences in effect were quite evident when compared with random data using a range of fifteen I.Q. points in level two. Further research could well be carried out with groups of narrow range at the top or bottom of the ability curve in the various subjects.

Further, the significant difference in achievement by subjects raises the question of subject differences in objectives, content and methodology. It is possible that this factor may affect significance

as much as the original achievement level.

Finally, in the analysis we have used both matched pairs and random selection, and both methods appear to have validity. Generally the conclusions for either method are similar. It would appear that, if the number of cases used is fairly large, there would be little difference between the methods in the means of pupil characteristics. In such circumstances the use of randomly selected cases requires less effort and might be the preferred method.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

Carpenter, D. R. and E. L. Miller, editors, "Ability Grouping," The Education Index, Vol. 8, June, 1950-May, 1953. New York: The H. W. Wilson Company, 1953.

Cook, W. W. and T. Clymer, "Acceleration and Retardation," The National Society for the Study of Education Yearbook, 1961, Part One. Chicago: University of Chicago Press, 1962.

Dixon, W. J. and F. J. Massey. Introduction to Statistical Analysis. Toronto: McGraw-Hill, 1957.

Ferguson, G. A., "Laycock Mental Ability Test," in O. K. Buros (ed.). The Third Mental Measurements Yearbook. New Brunswick: Rutgers University Press, 1949.

Ferguson, G. A. Statistical Analysis in Psychology and Education. Toronto: McGraw-Hill, 1959.

Goodlad, J. I., "Classroom Organization--Horizontal Organization: Ability Grouping," in Chester W. Harris (ed.), Encyclopaedia of Educational Research. New York: The Macmillan Company, 1960.

Guilford, J. P. Fundamental Statistics in Psychology and Education. Toronto: McGraw-Hill, 1956.

Lindquist, E. F. Design and Analysis of Experiments in Psychology and Education. Boston: Houghton Mifflin Company, 1953.

McNemar, Q. Psychological Statistics. New York: John Wiley and Sons, 1962.

Otto, H. J., "Elementary Education--III. Organization and Administration--Classification of Pupils," in Walter S. Munroe (ed.), Encyclopaedia of Educational Research. New York: The Macmillan Company, 1950.

Ray, W. S. An Introduction to Experimental Design. New York: The Macmillan Company, 1960.

Seng, Minnie A. (ed.), "Ability Grouping," The Education Index, Vol. 12, July, 1959-June, 1961. New York: The H. W. Wilson Company, 1961.

Tyler, F. T., "Intra-individual Variability," The National Society for The Study of Education, Yearbook 61, Part One. Chicago: The University of Chicago Press, 1962.

Walker, H. M. and J. Lev. Elementary Statistical Methods. New York: Holt, Rinehart and Winston, 1958.

Whipple, Guy M. (ed.), "The Grouping of Pupils," Thirty-fifth Yearbook, Part 1, The National Society for the Study of Education. Bloomington, Illinois: The Public School Publishing Company, 1936.

Winer, B. J. Statistical Principles in Experimental Design. Toronto: McGraw-Hill, 1962.

B. PERIODICALS

Baker, H. S., "Second Thoughts on Grouping," The Alberta Teachers' Association Magazine, 39 (March, 1959), p. 34.

Balow, I. H., "The Effects of 'Homogeneous' Grouping in Seventh-Grade Arithmetic," The Arithmetic Teacher, XI:3 (March, 1964), p. 191.

Baughman, M. D. and D. Schoonmaker, "Grouping Practices in Junior High," The Clearing House (October, 1961), pp. 111-112.

Buell, C. E. "How Much Grouping in the Junior High School," The National Association of Secondary School Principals, Bulletin 44 (April, 1960), pp. 49-60.

_____. "What Do We Believe About Grouping for Instruction in the Junior High School?" The National Association of Secondary School Principals Bulletin 46 (October, 1962), pp. 18-19.

Carbone, R. F., "The Non-graded School: An Appraisal," The Administrators' Notebook, X:1 (September, 1961), pp. 2,4.

Clarke, S. C. T. and S. Richel, "The Effect of Class Size and Teacher Qualifications on Achievement," Research Monograph Number 5 (Edmonton: The Alberta Teachers' Association, April, 1963), p. 71.

Cook, W. W., "The Gifted and the Retarded in Historical Perspective," Phi Delta Kappan, 39 (March, 1958), p. 252.

Cunningham, Luvern L., "Effecting Organizational Change," The Alberta School Principal, 1962 (Edmonton: The University of Alberta Press, 1962), p. 124.

Dockrell, W. B., "Special Education for Gifted Children," The Canadian Education and Research Digest, 11:1 (March, 1962), pp. 40-43.

Eddy, W. P., "Teacher Characteristics and Grade Nine Social Studies Achievement," The Alberta Journal of Educational Research, IX (December, 1963), p. 261.

Ekstrom, R. B., "Experimental Studies of Homogeneous Grouping: A Critical Review," School Review, 29 (Summer, 1961), p. 220.

Enns, F., "Assessing the Effects of Change," The Alberta School Principal, 1962 (Edmonton: The University of Alberta Press, 1962), p. 168.

Godwin, R. L., "Improving Instructional Procedures to Meet Individual Differences in the Senior High School," The Alberta School Principal, 1962 (Edmonton: The University of Alberta Press, 1962), p. 71.

Goldberg, M. L. and A. H. Passow, "The Effects of Ability Grouping," Education, 82 (April, 1962), p. 487.

Goodlad, J. I., "Planning and Organizing for Teaching," National Educational Association Project of the United States (Washington, 1963), pp. 71,91.

Housego, I. E. and G. L. Mowat, "Alberta Composite High Schools and Gifted Youth," The Alberta Journal of Educational Research (March, 1959), p. 124.

Lindstedt, S. A., "Teacher Qualifications and Grade Nine Mathematics Achievement," The Alberta Journal of Educational Research, VI:2 (June, 1960), p. 83.

Marklund, S., "Scholastic Attainments as Related to Size and Homogeneity of Classes," Educational Research, VI:1 (November, 1963), p. 64.

Passow, A. H., "The Maze of Research on Ability Grouping," Educational Forum, 26 (March, 1962), pp. 281-287.

Sauvain, W. H., "A Study of the Opinions of Certain Professional and Non-Professional Groups Regarding Homogeneous or Ability Grouping," Contributions to Education, No. 596 (New York: Bureau of Publications, Teachers College, Columbia University, 1934), p. 1.

Saville, Anthony, "Ability Grouping in Missouri High Schools," Journal of Secondary Education, 37 (February, 1962), pp. 93-96.

Seng, Minnie A. (ed.), "Ability Grouping," The Education Index, Vol. 12, July 1959-June 1961 (New York: The H. W. Wilson Company, 1961), pp. 3,4.

Shane, H. G., "Grouping Practices," The Nation's Schools, 49 (May, 1952), pp. 72,73.

Veatch, Jeanette, "Grouping is the Function and Process of Content," Educational Leadership, 18 (April, 1961), p. 426.

Wilhelms, F. T. and D. Westby-Gibson, "Grouping: Research Offers Leads," Educational Leadership, 18 (April, 1961), p. 411.

Worth, W. H., "Proposals for Improved Organization of the Elementary School," The Alberta School Principal, 1962 (Edmonton: The University of Alberta Press, 1962), p. 59.

C. UNPUBLISHED MATERIALS

Dockrell, W. B., "Edmonton Junior High School Streaming Projects," Committee Report (Edmonton: Division of Educational Psychology, University of Alberta, 1961), pp. 1,2. (Mimeographed.)

Wasylyk, E., "The Relation Between Selected Teacher Characteristics and Student Achievement in Grade Twelve Mathematics. Unpublished Master's thesis, the University of Alberta, Edmonton, 1961.

APPENDICES

APPENDIX A

STANINE ACHIEVEMENT OF PARKVIEW GRADE NINE STUDENTS

FOR THE YEARS 1957 - 1964

Matched Pairs

1. Level One--Table XLII
2. Level Two--Table XLIII
3. Level Three--Table XLIV

Random Data

1. Level One--Table XLV
2. Level Two--Table XLVI
3. Level Three--Table XLVII

TABLE XLII

STANINE ACHIEVEMENT OF PARKVIEW GRADE NINE STUDENTS
MATCHED PAIRS--LEVEL ONE

	1957-59 Heterogeneous								1960-62 Homogeneous								1963-64 Subject Group'g							
Students	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6
1	9	9	8	7	6	8	21	47	9	7	8	9	8	9	26	50	8	9	7	7	7	8	22	46
2	7	8	7	6	7	7	20	42	8	8	8	9	7	8	24	48	6	8	6	7	7	6	20	40
3	7	8	6	7	7	7	21	42	9	9	9	8	8	9	25	52	8	8	8	8	8	7	23	47
4	9	9	9	9	7	7	23	50	8	8	9	9	7	8	24	49	9	8	9	9	9	9	27	53
5	9	7	6	5	6	8	19	41	7	7	9	9	8	9	26	49	8	5	8	7	7	7	21	42
6	9	9	9	8	7	8	23	50	7	9	8	9	9	8	26	50	8	9	9	9	9	9	27	53
7	6	9	8	7	6	7	20	43	8	7	7	4	8	8	20	42	6	7	6	7	7	7	21	40
8	6	8	7	6	6	8	20	41	9	9	9	8	8	9	25	52	5	8	7	7	7	7	21	41
9	9	7	5	4	6	5	15	36	9	9	9	9	8	9	26	53	7	6	6	6	5	5	16	35
10	8	9	7	7	5	7	19	43	6	8	7	7	6	5	18	39	9	9	8	8	8	7	23	49
11	7	9	8	8	8	7	23	47	6	8	8	7	7	8	22	44	5	6	8	9	8	7	24	43
12	8	8	8	7	6	7	20	44	6	7	6	5	6	6	17	36	9	9	8	9	8	7	24	50
13	8	9	6	8	5	7	20	43	7	8	8	7	6	7	20	43	6	7	8	9	7	6	22	43
14	8	7	7	6	5	6	17	39	7	9	6	7	7	7	21	43	9	9	9	9	9	8	26	53
15	8	5	5	5	6	7	18	36	8	9	7	8	7	7	22	46	8	6	8	7	8	6	21	43
16	9	9	9	8	8	9	25	52	8	7	7	8	7	8	23	45	7	8	7	7	7	7	21	43
17	7	8	7	7	6	7	20	42	7	9	8	8	7	7	22	46	6	8	8	9	9	7	25	47
18	5	4	5	4	4	5	13	27	7	7	7	6	6	7	19	40	6	6	6	7	6	6	19	37
19	6	5	4	6	5	5	16	31	8	7	7	8	6	6	20	42	7	9	8	8	9	9	26	50
20	6	8	7	7	8	8	23	44	8	5	8	6	9	9	24	45	5	6	6	6	7	7	20	37
21	5	5	4	4	6	6	16	30	7	7	6	6	7	7	20	40	7	8	9	8	8	8	24	48
22	9	9	8	8	7	9	24	50	9	9	9	9	8	9	26	53	9	9	7	9	7	7	23	48
23	7	7	6	8	8	8	24	44	9	9	7	7	6	7	20	45	7	9	7	9	8	7	24	47
24	5	7	7	6	7	7	20	39	7	7	7	7	5	5	17	38	7	9	8	9	9	9	27	51
25	9	9	9	7	7	8	22	49	9	8	7	6	6	5	17	41	8	7	9	6	6	6	18	42
26	7	9	8	8	6	8	22	46	7	7	8	5	9	7	21	43	8	8	7	8	8	8	24	47
27	8	8	7	5	6	7	18	41	5	7	7	6	8	7	21	40	8	9	9	9	9	8	26	52
28	7	6	5	5	4	4	13	31	7	9	9	7	7	8	22	47	7	7	8	9	6	5	20	42
29	8	9	8	8	7	8	23	48	6	7	8	6	6	6	18	39	6	9	8	8	7	7	22	45
30	6	5	7	5	8	7	20	38	8	9	9	8	7	7	22	48	9	9	9	8	6	8	22	49
31	6	6	8	6	7	7	20	40	6	5	9	6	8	8	22	42	7	9	7	9	8	6	23	46
32	5	7	7	7	6	5	18	37	6	7	6	7	6	6	19	38	6	9	7	9	8	8	25	47
ΣX	233	242	222	209	203	224	636	1333	238	248	247	231	228	236	695	1428	231	253	245	256	242	229	727	1456

Sum 3 = Sum of Language, Mathematics and Science scores.

TABLE XLIII

STANINE ACHIEVEMENT OF PARKVIEW GRADE NINE STUDENTS
MATCHED PAIRS--LEVEL TWO

	1957-59 Heterogeneous								1960-62 Homogeneous								1963-64 Subject Group'g							
Student	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6
33	6	6	6	7	6	7	20	38	6	6	6	5	5	7	17	35	6	7	7	8	7	8	23	43
34	6	6	5	5	4	6	15	32	5	5	6	4	4	5	13	29	4	4	5	5	6	5	16	29
35	6	8	6	4	6	7	17	37	7	6	7	6	6	8	20	40	5	5	6	5	6	6	17	33
36	7	7	7	8	7	6	21	42	7	6	5	7	5	6	18	36	6	4	6	6	8	6	20	36
37	8	9	8	7	6	6	19	44	8	5	5	6	6	7	19	37	4	8	7	8	7	7	22	41
38	6	6	7	8	6	7	21	40	8	8	7	6	6	7	19	42	9	6	5	8	7	5	20	40
39	5	4	6	4	3	3	10	25	6	6	7	4	7	8	19	38	6	8	7	6	7	7	20	41
40	7	7	7	5	7	6	18	39	6	8	9	7	8	9	24	47	6	7	6	7	8	7	22	41
41	6	8	5	8	4	3	15	34	5	7	6	8	6	6	20	38	8	9	6	7	6	6	19	42
42	7	6	6	6	4	6	16	35	6	4	5	4	5	5	14	29	6	6	9	8	6	7	21	42
43	9	7	7	7	7	7	21	44	9	7	8	7	7	7	21	45	9	9	7	8	7	7	22	47
44	7	5	5	5	5	5	15	32	6	6	7	7	7	7	21	40	7	7	5	7	5	4	16	35
45	5	6	5	6	5	6	17	33	7	6	7	7	6	7	20	40	6	7	6	7	7	6	20	39
46	6	7	6	5	4	6	15	34	5	6	6	6	6	7	19	36	5	6	7	5	6	6	17	35
47	6	5	7	5	7	7	19	37	9	8	7	8	7	8	23	47	6	6	6	7	8	7	22	40
48	7	4	5	5	6	6	17	33	6	5	5	7	6	6	19	35	7	6	7	5	6	7	18	38
49	5	5	5	8	7	6	21	36	8	8	7	7	6	6	19	42	4	7	6	7	6	5	18	35
50	7	8	6	6	6	6	18	39	7	7	7	7	8	7	22	43	6	5	6	6	7	6	19	36
51	8	9	8	9	6	6	21	46	6	8	6	7	8	7	22	42	8	7	8	8	6	6	20	43
52	7	8	8	6	6	7	19	22	8	6	6	5	5	6	16	36	9	5	6	8	6	6	20	40
53	5	7	8	8	9	9	26	46	9	8	6	8	7	5	20	43	7	5	7	7	7	6	20	39
54	5	5	7	4	6	7	17	34	6	6	6	5	7	6	18	36	7	8	6	8	6	7	21	42
55	5	8	6	8	6	6	20	39	5	6	7	7	6	6	19	37	7	6	5	7	8	6	21	39
56	8	7	6	5	6	7	18	39	7	8	7	7	6	6	19	41	6	7	6	8	4	5	17	36
57	6	7	9	8	7	7	22	44	4	4	5	5	6	7	18	31	6	4	4	4	5	4	13	27
58	8	7	7	6	5	7	18	40	7	7	8	9	7	9	25	47	5	8	7	7	6	6	19	39
59	5	5	5	5	5	5	15	30	5	7	7	6	6	7	19	38	5	5	7	4	6	6	16	33
60	5	3	5	5	6	6	17	30	7	5	7	6	6	6	18	37	4	4	2	5	5	3	13	23
61	7	5	7	6	6	8	20	39	6	7	6	8	6	7	21	40	5	5	6	5	7	6	18	34
62	6	8	6	6	6	6	18	38	6	5	6	6	5	6	17	34	5	7	7	8	7	6	21	40
63	6	8	5	5	7	6	18	37	8	8	7	6	7	8	21	44	4	7	6	6	6	6	18	35
64	5	5	5	4	5	6	15	30	8	8	6	6	6	8	20	42	5	6	5	5	4	6	15	31
∑X	202	206	201	194	186	199	579	1188	213	207	207	204	199	217	620	1247	193	201	196	210	203	191	604	1194

TABLE XLIV

STANINE ACHIEVEMENT OF PARKVIEW GRADE NINE STUDENTS
MATCHED PAIRS--LEVEL THREE

	1957-59 Heterogeneous								1960-62 Homogeneous								1963-64 Subject Group'g							
Students	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6
65	4	6	5	5	6	6	17	32	4	6	4	5	8	6	19	33	6	6	6	6	7	6	19	37
66	6	5	2	4	6	3	13	26	6	6	6	5	5	6	16	34	6	7	4	6	3	5	14	31
67	6	9	5	7	4	4	15	35	7	4	6	5	6	6	17	34	4	4	3	5	6	3	14	25
68	7	7	5	7	4	7	18	37	5	5	5	6	4	5	15	30	6	5	5	4	4	3	11	27
69	4	5	5	5	7	7	19	33	4	4	6	4	4	5	13	27	3	5	5	6	5	8	21	35
70	7	5	7	5	5	5	15	34	7	9	7	9	7	8	24	47	6	5	6	6	4	4	14	31
71	5	4	6	5	6	7	18	33	4	6	8	6	8	8	22	40	6	6	7	8	6	6	20	39
72	5	5	3	6	2	2	10	23	7	9	5	7	4	6	17	38	3	3	5	5	4	5	14	25
73	4	4	4	2	3	4	9	21	8	5	7	5	7	8	20	40	6	6	7	4	6	6	16	35
74	5	5	4	4	4	5	13	27	5	5	7	6	7	8	21	38	6	9	7	8	9	9	26	48
75	6	8	8	6	7	8	21	43	4	2	6	6	5	6	17	29	4	5	6	6	6	5	17	32
76	5	6	8	6	6	6	18	37	5	8	7	8	4	6	18	38	7	6	6	8	5	5	18	37
77	8	7	6	7	5	6	18	39	5	5	5	6	5	5	16	31	7	9	9	9	8	9	26	51
78	2	4	4	3	5	4	12	22	5	2	4	3	5	6	14	25	6	6	5	5	6	5	16	33
79	4	2	3	4	2	3	9	18	4	5	4	5	5	4	14	27	7	6	8	8	8	7	23	44
80	5	6	6	6	6	7	19	36	4	6	6	4	4	6	16	35	7	6	9	8	9	9	26	48
81	7	5	5	5	5	4	14	31	5	4	6	4	5	4	13	28	4	5	3	8	4	2	14	26
82	5	4	4	3	2	5	10	23	5	3	6	3	4	5	12	26	6	6	7	6	6	6	18	37
83	5	6	5	4	2	3	9	25	5	5	6	4	6	5	15	31	3	4	4	4	5	4	13	24
84	4	6	6	4	4	6	14	30	5	2	5	3	5	4	12	24	5	4	5	6	2	4	12	26
85	6	7	5	5	3	5	13	31	4	4	5	5	8	5	18	31	5	5	5	4	5	5	14	29
86	6	4	5	4	1	5	10	25	4	4	6	2	5	5	12	26	3	5	5	4	7	7	18	31
87	4	6	5	5	3	7	15	30	5	3	3	4	5	4	13	24	4	4	5	3	5	5	13	26
88	4	4	3	2	2	3	7	18	5	2	4	5	4	5	14	25	6	6	5	6	5	4	15	32
89	4	3	2	3	3	3	9	18	2	3	3	4	2	3	9	17	6	6	3	4	3	4	11	26
90	5	5	5	5	5	4	14	29	4	4	5	4	3	3	10	23	3	5	6	6	6	5	17	31
91	6	7	5	6	5	6	17	35	8	7	5	6	5	6	17	37	5	7	5	6	5	5	16	33
92	4	4	5	4	3	7	14	27	7	4	6	3	2	6	11	28	3	3	6	4	5	6	15	27
93	6	5	4	5	4	6	15	30	5	3	4	4	4	4	12	24	3	3	3	4	3	1	8	17
94	3	2	3	4	2	3	9	17	5	5	4	3	3	5	11	25	5	5	3	4	3	5	12	25
95	4	5	5	5	2	5	12	26	5	4	3	5	5	4	14	26	3	4	4	6	4	3	13	24
96	3	3	6	4	1	4	9	21	1	2	4	3	3	3	9	16	3	3	2	3	1	2	6	14
$\sum X$	159	164	154	150	125	160	435	912	162	146	168	153	158	170	481	957	157	169	170	179	168	163	510	1006

TABLE XLV

STANINE ACHIEVEMENT OF PARKVIEW GRADE NINE STUDENTS
RANDOM DATA--LEVEL ONE

	1957-59 Heterogeneous								1960-62 Homogeneous								1963-64 Subject Grouping							
Student	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6
1	9	9	8	7	6	8	21	47	9	9	9	9	9	9	27	54	9	9	8	9	9	8	26	52
2	7	8	7	6	7	7	20	42	8	9	7	9	9	7	25	49	9	9	7	8	8	6	22	47
3	7	8	6	7	7	7	21	42	9	8	8	8	9	9	26	51	9	9	9	9	8	6	23	50
4	9	8	8	8	8	7	23	48	8	8	8	9	7	8	24	48	7	8	8	8	9	6	23	46
5	9	7	6	5	6	8	19	41	7	7	8	8	6	7	21	43	7	6	7	6	8	6	20	40
6	9	9	9	9	7	7	23	50	7	9	8	7	6	7	20	44	9	8	9	8	9	8	25	51
7	8	9	9	9	9	9	27	53	6	8	8	9	9	8	26	48	8	9	7	7	7	8	22	46
8	9	7	6	5	7	5	17	39	7	7	9	9	8	9	26	49	6	8	6	7	7	6	20	40
9	6	8	7	8	7	7	22	43	7	9	8	9	9	8	26	50	9	8	6	6	7	6	19	42
10	8	9	7	7	5	7	19	43	8	8	7	8	8	8	24	47	8	7	8	8	7	7	22	45
11	6	6	6	5	7	7	19	37	8	9	8	9	7	9	25	50	8	8	8	8	8	7	23	47
12	6	9	8	7	6	7	20	43	6	7	7	8	9	8	25	45	9	9	9	9	8	9	26	53
13	9	9	6	9	5	5	19	43	9	7	7	8	9	9	26	49	9	7	9	9	8	7	24	49
14	9	7	5	7	4	4	15	36	9	9	9	8	9	9	26	53	9	8	9	9	9	9	27	53
15	6	8	7	6	6	8	20	41	8	7	7	4	8	8	20	42	7	6	5	7	4	4	15	33
16	7	9	8	8	8	7	23	47	9	8	9	6	9	8	23	49	9	8	8	7	7	6	20	45
17	8	9	7	7	5	7	19	43	9	9	9	8	8	9	25	52	8	8	7	8	7	7	22	45
18	8	8	8	7	6	7	20	44	6	8	8	7	7	8	22	44	9	9	8	9	7	8	24	50
19	8	7	7	6	5	6	17	39	6	7	6	5	6	6	17	36	8	9	9	9	9	9	27	53
20	8	9	6	8	5	7	20	43	8	6	6	6	6	7	19	39	8	9	9	9	8	8	25	51
21	9	6	8	5	7	7	19	42	5	7	4	6	5	4	15	31	6	6	5	6	5	5	16	33
22	8	5	5	5	6	7	18	36	8	7	9	8	7	9	24	48	7	5	6	9	8	7	24	42
23	8	7	6	8	7	7	22	43	7	7	6	8	6	6	20	40	7	6	6	6	5	5	16	35
24	9	9	9	8	8	9	25	52	7	7	7	7	8	7	22	43	7	6	5	4	6	6	16	34
25	7	8	7	7	6	7	20	42	8	7	7	7	7	8	22	44	9	9	8	9	8	7	24	50
26	5	4	5	4	4	5	13	27	7	8	9	6	7	7	20	44	6	7	8	9	7	6	22	43
27	5	5	4	4	6	6	16	30	7	7	6	7	8	7	22	42	9	9	9	9	9	8	26	53
28	6	5	4	6	5	5	16	31	7	9	9	8	8	8	24	49	8	5	5	7	6	6	19	37
29	6	8	7	7	8	8	23	44	6	8	6	7	8	6	21	41	7	9	7	9	8	7	24	47
30	7	8	7	7	7	6	20	42	6	9	9	9	9	9	27	51	8	7	9	6	6	6	18	42
31	5	5	4	4	6	6	16	30	9	9	9	9	8	9	26	53	7	8	9	8	8	8	24	48
32	7	7	6	8	8	8	24	44	6	6	6	6	6	6	18	36	5	6	6	6	7	7	20	37
∑X	238	240	213	214	204	218	636	1327	237	250	243	242	245	247	734	1464	251	245	239	248	237	219	704	1439

TABLE XLVI

STANINE ACHIEVEMENT OF PARKVIEW GRADE NINE STUDENTS
RANDOM DATA--LEVEL TWO

	1957-59 Heterogeneous								1960-62 Homogeneous								1963-64 Subject Group'g							
Student	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6
33	5	7	7	6	7	7	20	39	6	8	4	8	4	4	16	34	7	7	8	9	6	5	20	42
34	7	8	7	7	7	7	21	43	8	6	6	8	7	7	22	42	8	9	9	9	9	8	26	52
35	7	9	8	8	6	8	22	46	9	6	7	6	9	7	22	44	5	5	7	4	5	6	15	32
36	6	4	4	4	4	5	13	27	7	8	8	7	7	8	22	45	7	5	6	6	5	6	17	35
37	5	7	5	6	4	6	16	33	7	6	5	5	6	5	16	34	8	8	7	8	8	8	24	47
38	6	6	6	7	6	7	20	38	6	6	8	6	7	6	19	39	6	9	8	8	7	7	22	45
39	6	6	5	5	4	6	15	32	9	6	6	6	6	8	20	41	9	9	9	8	6	8	22	49
40	7	7	5	7	5	6	18	37	8	8	8	8	8	9	25	49	6	9	7	9	8	8	25	47
41	6	8	6	4	6	7	17	37	8	9	9	8	7	7	22	48	6	7	7	8	7	8	23	43
42	7	7	7	8	7	6	21	42	6	7	8	7	8	7	22	43	4	8	7	8	7	7	22	41
43	8	9	8	7	6	6	19	44	7	7	7	7	7	7	21	42	6	6	9	8	6	7	21	42
44	6	6	7	8	6	7	21	40	9	8	8	8	7	7	22	47	7	7	7	7	6	7	20	41
45	6	5	6	6	6	6	18	35	5	5	5	5	5	4	14	29	9	6	5	8	7	5	20	40
46	5	4	6	4	3	3	10	25	4	4	7	4	6	7	17	32	8	9	6	7	6	6	19	42
47	4	5	6	6	7	7	20	35	7	6	7	6	6	8	20	40	7	6	5	6	7	5	18	36
48	9	7	7	7	7	7	21	44	5	5	5	4	6	6	16	31	6	7	6	7	8	7	22	41
49	7	6	6	6	4	6	16	35	7	6	7	6	5	6	17	37	6	5	6	6	7	6	19	36
50	5	6	5	6	5	6	17	33	8	5	5	6	6	7	19	37	4	7	6	7	6	5	18	35
51	6	5	7	5	7	7	19	37	7	7	7	7	5	6	18	39	5	6	7	5	6	6	17	35
52	4	3	3	5	5	4	14	24	6	3	4	4	3	4	11	24	7	5	6	5	5	6	16	34
53	7	6	5	5	4	4	13	31	6	4	5	4	5	5	14	29	6	7	6	7	7	6	20	39
54	5	5	5	8	7	6	21	36	6	6	7	7	7	7	21	40	5	5	6	5	6	6	17	33
55	6	7	6	7	6	5	18	37	6	6	6	6	7	7	20	38	7	8	6	8	6	7	21	42
56	7	8	6	6	6	6	18	39	9	8	7	8	7	8	23	47	7	5	7	7	7	6	20	39
57	6	7	4	4	4	4	12	29	5	5	6	6	6	5	17	33	6	7	5	6	3	5	14	32
58	5	7	8	8	9	9	26	46	4	5	7	6	7	7	20	36	6	7	6	8	4	5	17	36
59	7	8	8	6	6	7	19	42	8	6	6	5	5	6	16	36	5	8	7	7	6	6	19	39
60	6	5	4	3	4	5	12	27	4	4	4	3	3	3	9	21	5	7	6	7	7	6	20	38
61	6	4	4	3	3	3	9	23	5	6	7	7	6	6	19	37	5	5	5	6	5	6	17	32
62	5	6	3	7	4	2	13	27	4	4	5	5	6	7	18	31	4	4	2	5	5	3	13	23
63	6	8	5	5	7	6	18	37	6	5	7	4	6	6	16	34	6	7	4	6	3	5	14	31
64	8	7	7	6	5	7	18	40	4	4	5	4	3	4	11	24	5	6	5	5	4	6	15	31
∑X	196	203	186	190	177	188	555	1140	206	189	203	191	193	201	585	1183	198	216	203	220	195	198	613	1230

TABLE XLVII

STANINE ACHIEVEMENT OF PARKVIEW GRADE NINE STUDENTS
RANDOM DATA--LEVEL THREE

	1957-59 Heterogeneous								1960-62 Homogeneous								1963-64 Subject Group'g							
Student	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6	Reading	Literature	Soc.Studies	Language	Mathematics	Science	Sum 3	Sum 6
65	5	3	5	5	6	6	17	30	8	8	7	6	7	8	21	44	3	3	5	5	4	5	14	25
66	4	6	5	5	6	6	17	32	6	6	6	5	5	6	16	34	6	5	6	6	4	4	14	31
67	6	9	5	7	4	4	15	35	7	8	8	5	5	6	16	39	6	6	6	6	7	6	19	37
68	8	5	6	5	6	6	17	36	6	5	4	5	5	5	15	30	8	6	7	9	8	6	23	44
69	7	7	7	6	6	5	17	38	3	3	4	4	6	4	14	24	4	4	3	5	6	3	14	25
70	6	6	5	6	5	5	16	33	7	9	7	9	7	8	24	47	6	5	5	4	4	3	11	27
71	5	5	4	4	4	5	13	27	7	9	5	7	4	6	17	38	6	6	7	4	6	6	16	35
72	5	6	5	5	3	6	14	30	8	5	7	5	7	8	20	40	6	6	7	8	6	6	20	39
73	6	7	5	6	3	5	14	32	5	7	5	6	5	5	16	33	7	6	6	6	4	5	15	34
74	8	7	8	5	6	8	19	42	4	5	5	4	5	5	14	28	6	9	7	8	9	9	26	48
75	4	5	3	5	5	5	15	27	4	6	5	6	6	5	17	32	4	5	6	6	6	5	17	32
76	5	4	4	2	3	4	9	22	5	6	7	7	8	6	21	39	7	6	6	8	5	5	18	37
77	4	2	3	4	2	3	9	18	4	4	5	5	7	7	19	32	7	6	8	8	8	7	23	44
78	5	6	6	6	6	7	19	36	7	6	6	5	5	6	16	35	7	6	9	8	9	9	26	48
79	6	6	5	5	3	2	10	27	5	3	6	3	4	5	12	26	5	4	5	6	2	4	12	26
80	6	5	6	3	4	6	13	30	5	5	4	4	4	4	12	26	5	5	6	6	7	6	19	35
81	6	5	5	5	3	4	12	28	4	6	6	4	7	6	17	33	6	6	5	5	6	5	16	33
82	5	6	5	4	2	3	9	25	6	7	7	7	6	7	20	40	3	5	5	4	7	7	18	31
83	6	5	6	5	4	4	13	30	5	5	5	5	4	5	14	29	4	3	4	4	6	4	14	25
84	4	6	5	5	3	7	15	30	3	6	5	7	8	5	20	34	6	6	5	6	5	4	15	32
85	2	3	3	3	2	2	7	15	6	5	4	6	4	5	15	30	4	4	5	5	6	6	17	30
86	6	4	5	4	1	5	10	25	5	4	4	4	4	5	13	26	4	5	4	5	3	4	12	25
87	4	4	3	2	2	3	7	18	4	4	3	5	3	4	12	23	4	4	5	3	5	5	13	26
88	4	3	2	3	3	3	9	18	4	4	5	5	8	5	18	31	5	4	2	5	1	3	9	20
89	5	5	5	5	5	4	14	29	5	2	4	5	4	5	14	25	5	7	5	6	5	5	16	33
90	3	3	3	4	2	3	9	18	5	6	5	4	4	5	13	29	4	3	3	2	4	3	9	19
91	6	6	7	5	4	6	15	34	4	6	6	5	4	6	15	31	6	4	5	3	3	4	10	25
92	4	4	5	4	3	7	14	27	8	7	5	6	5	6	17	37	4	4	6	3	3	5	11	25
93	5	5	2	3	5	4	12	24	4	2	4	3	3	5	11	21	3	3	6	4	5	6	15	27
94	4	4	5	6	6	6	18	31	3	1	4	5	4	3	12	20	3	4	4	6	4	3	13	24
95	4	4	5	3	4	6	13	26	4	3	3	5	2	3	10	20	5	3	4	3	3	3	9	21
96	3	2	3	4	2	3	9	17	1	2	4	3	3	3	9	16	3	3	2	3	1	2	6	14
$\sum X$	161	158	151	144	123	153	420	890	162	165	165	165	163	172	500	992	162	156	169	170	162	158	490	977

APPENDIX B

ANALYSIS OF VARIANCE: THREE-WAY CLASSIFICATION--2 x 3 x 6

Matched Pairs--Table XLVIII

Random Data--Table XLIX

TABLE XLVIII

COMPUTATION FOR ANALYSIS OF VARIANCE: 2 x 3 x 6 (MATCHED PAIRS)

Rows - B Levels	Block 1 (Heterogeneous) - A Subjects (Columns) - C						
	Reading	Literature	Social Studies	Language	Mathematics	Science	Total
Level 1	233	242	222	209	203	224	1333
	7.281	7.563	6.938	6.531	6.344	7.000	
Level 2	202	206	201	194	186	199	1188
	6.313	6.438	6.281	6.063	5.813	6.219	
Level 3	159	164	154	150	125	160	912
	4.969	5.125	4.813	4.688	3.906	5.000	
Total	594	612	577	553	514	583	3433
	6.188	6.375	6.010	5.760	5.354	6.073	
	Block 2 (homogeneous)						
Level 1	238	248	247	231	228	236	1428
	7.438	7.750	7.719	7.219	7.125	7.375	
Level 2	213	207	207	204	199	217	1247
	6.656	6.469	6.469	6.375	6.219	6.781	
Level 3	162	146	168	153	158	170	957
	5.063	4.563	5.250	4.783	4.938	5.313	
Total	613	601	622	588	585	623	3632
	6.385	6.260	6.479	6.125	6.094	6.490	
	Totals: Block 1 and 2						
Level 1	471	490	469	440	431	460	2761
Level 2	415	413	408	398	385	416	2435
Level 3	321	310	322	303	283	330	1869
Total	1207	1213	1199	1141	1099	1206	7065
	6.286	6.318	6.245	5.943	5.724	6.281	

$\sum_{a=1}^{A}\sum_{b=1}^{B}\sum_{c=1}^{C} X_{abc}^2 = 46,505.$ $\quad \sum (\sum X_{abc})^2 = 1,424,923.$

$\sum_{a} (\sum_{b}\sum_{c} X_{abc})^2 = 24,976,913.$ $\quad \sum_{b} (\sum_{a}\sum_{c} X_{abc})^2 = 17,045,507.$

$\sum_{c} (\sum_{a}\sum_{b} X_{abc})^2 = 8,329,937.$ $\quad T^2 = 49,914,225.$ $\quad \sum_{a}\sum_{b} (\sum_{c} X_{abc})^2 = 8,530,019.$

$\sum_{a}\sum_{c} (\sum_{b} X_{abc})^2 = 4,170,155.$ $\quad \sum_{b}\sum_{c} (\sum_{a} X_{abc})^2 = 2,845,429.$

Applying the computation formulas, the calculations are as follows:

$$SS_T = \sum_{a-1}\sum_{b-1}\sum_{c-1} X_{abc}^2 - \frac{T^2}{mABC} = 46,505 - 43,328.3 = 3176.7$$

$$SS_{cells} = \frac{\sum (\sum X_{abc})^2}{m} - \frac{T^2}{mABC} = 44,528.8 - 32,328.3 = 1200.5$$

$$SS_w = SS_T - SS_{cells} = 3176.7 - 1200.5 = 1976.2$$

Grouping:

$$SS_A = \frac{1}{mBC}\sum_{a} (\sum_{b}\sum_{c} X_{abc})^2 - \frac{T^2}{mABC} = \frac{24,976,913}{576} - \frac{7065^2}{1152} = 34.4$$

Levels:

$$SS_B = \frac{1}{mAC}\sum_{b} (\sum_{a}\sum_{c} X_{abc})^2 - \frac{T^2}{mABC} = \frac{17,045,507}{384} - \frac{7065^2}{1152} = 1061.0$$

Subjects;

$$SS_C = \frac{1}{mAB}\sum_{c} (\sum_{a}\sum_{b} X_{abc})^2 - \frac{T^2}{mABC} = \frac{8,329,937}{192} - 43,328.3 = 56.8$$

Interaction:

$$SS_{AB} = \frac{1}{mC}\sum_{a}\sum_{b} (\sum_{c} X_{abc})^2 - \frac{T^2}{mABC} - SS_A - SS_B = \frac{8,530,019}{192} - 43,328.3 - 34.4 - 1061 = 3.5.$$

$$SS_{AC} = \frac{1}{mB}\sum_{a}\sum_{c} (\sum_{b} X_{abc})^2 - \frac{T^2}{N} - SS_A - SS_C = \frac{4,170,155}{96} - 43,328.3 - 34.4 - 56.8 = 19.6$$

$$SS_{BC} = \frac{1}{mA}\sum_{b}\sum_{c} (\sum_{a} X_{abc})^2 - \frac{T^2}{N} - SS_B - SS_C = \frac{2,845,429}{64} - 43,328.3 - 1061 - 56.8 = 13.7.$$

$$SS_{ABC} = SS_{cells} - SS_A - SS_B - SS_C - SS_{AB} - SS_{AC} - SS_{BC} =$$

$$1200.5 - 34.4 - 1061 - 56.8 - 3.5 - 19.6 - 13.7 = 11.5$$

TABLE XLIX

COMPUTATION FOR ANALYSIS OF VARIANCE: 2 x 3 x 6 (RANDOM)

Rows - B Levels	Block 1 (Heterogeneous) - A Subjects (Columns) - C						
	Reading	Literature	Social Studies	Language	Mathematics	Science	Total
Level 1	238	240	213	214	204	218	1327
	7.438	7.500	6.656	6.688	6.375	6.813	
Level 2	196	203	186	190	177	188	1140
	6.125	6.344	5.813	5.938	5.531	5.875	
Level 3	161	158	151	144	123	153	890
	5.031	4.938	4.719	4.500	3.844	4.781	
Total	595	601	550	548	504	559	3357
	6.198	6.260	5.729	5.708	5.250	5.823	
	Block 2 (Homogeneous)						
Level 1	237	250	243	242	245	247	1464
	7.406	7.813	7.594	7.563	7.656	7.719	
Level 2	206	189	203	191	193	201	1183
	6.438	5.906	6.344	5.969	6.031	6.281	
Level 3	162	165	165	165	163	172	992
	5.063	5.156	5.156	5.156	5.094	5.375	
Total	605	604	611	598	601	620	3639
	6.302	6.292	6.365	6.229	6.260	6.458	
	Totals: Block 1 and 2						
Level 1	475	490	456	456	449	465	2791
Level 2	402	392	389	381	370	389	2323
Level 3	323	323	316	309	286	325	1882
Total	1200	1205	1161	1146	1105	1179	6996
	6.250	6.276	6.047	5.969	5.755	6.141	

$\sum_{a=1}^{A}\sum_{b=1}^{B}\sum_{c=1}^{C} X_{abc}^2 = 45,959.$ $\sum_{a}(\sum_{b}\sum_{c} X_{abc})^2 = 1,399,388.$ $\sum_{a}(\sum_{b}\sum_{c} X_{abc})^2 = 24,511,770.$

$\sum_{b}(\sum_{a}\sum_{c} X_{abc})^2 = 16,727,934.$ $\sum_{c}(\sum_{a}\sum_{b} X_{abc})^2 = 8,164,328.$ $T^2 = 48,944,016.$

$\sum_{a}\sum_{b}(\sum_{c} X_{abc})^2 = 8,379,478.$ $\sum_{a}\sum_{c}(\sum_{b} X_{abc})^2 = 4,091,894.$

$\sum_{b}\sum_{c}(\sum_{a} X_{abc})^2 = 2,790,810.$

Applying the computation formulas, the calculations are as follows:

$$SS_T = \sum_{a=1}^{A}\sum_{b=1}^{B}\sum_{c=1}^{C} X_{abc}^2 - \frac{T^2}{mABC} = 45,959 - 42,486.1 = 3472.9$$

$$SS_{cells} = \frac{\sum(\sum X_{abc})^2}{m} - \frac{T^2}{mABC} = 43,730.9 - \frac{48,944,016}{1152} = 1244.8$$

$$SS_W = SS_T - SS_{cells} = 3472.9 - 1244.8 = 2228.1$$

Grouping:

$$SS_A = \frac{1}{mBC}\sum_{a}(\sum_{b}\sum_{c} X_{abc})^2 - \frac{T^2}{mABC} = \frac{24,511,770}{576} - \frac{6996^2}{1152} = 69.1$$

Levels:

$$SS_B = \frac{1}{mAC}\sum_{b}(\sum_{a}\sum_{c} X_{abc})^2 - \frac{T^2}{mABC} = \frac{16,727,934}{384} - \frac{48,944,016}{1152} = 1076.2$$

Subjects:

$$SS_C = \frac{1}{mAB}\sum_{c}(\sum_{a}\sum_{b} X_{abc})^2 - \frac{T^2}{mABC} = \frac{8,164,328}{192} - 42,486.1 = 36.4$$

Interaction:

$$SS_{AB} = \frac{1}{mC}\sum_{a}\sum_{b}(\sum_{c} X_{abc})^2 - \frac{T^2}{mABC} - SS_A - SS_B = \frac{8,378,478}{192} - 42,486.1 - 69.1 - 1076.2 = 11.8$$

$$SS_{AC} = \frac{1}{mB}\sum_{a}\sum_{c}(\sum_{b} X_{abc})^2 - \frac{T^2}{mABC} - SS_A - SS_C = \frac{4,091,894}{96} - 42,486.1 - 69.1 - 36.4 = 32.3$$

$$SS_{BC} = \frac{1}{mA}\sum_{b}\sum_{c}(\sum_{a} X_{abc})^2 - \frac{T^2}{mABC} - SS_B - SS_C = \frac{2,790,810}{64} - 42,486.1 - 1076.2 - 36.4 = 7.7$$

$$SS_{ABC} = SS_{cells} - SS_A - SS_B - SS_C - SS_{AB} - SS_{AC} - SS_{BC} =$$

$$1244.8 - 69.1 - 1076.2 - 36.4 - 11.8 - 32.3 - 7.7 = 11.3.$$

APPENDIX C

ANALYSIS OF VARIANCE: THREE-WAY CLASSIFICATION--3 x 3 x 3

Matched Pairs--Table L

Random Data--Table LI

TABLE L

COMPUTATION FOR ANALYSIS OF VARIANCE: 3 x 3 x 3 (MATCHED)

Rows - B	Block 1 (Heterogeneous) - A Subjects (Columns) - C			
Levels	Language	Mathematics	Science	Total
Level 1	209 6.531	203 6.344	224 7.000	636
Level 2	194 6.063	186 5.813	199 6.219	579
Level 3	150 4.688	125 3.906	160 5.000	435
Total	553 5.760	514 5.354	583 6.073	1650
		Block 2 (Homogeneous)		
Level 1	231 7.219	228 7.125	236 7.375	695
Level 2	204 6.375	199 6.219	217 6.781	620
Level 3	153 4.783	158 4.938	170 5.313	481
Total	558 6.125	585 6.094	623 6.490	1796
		Block 3 (Subject Grouping)		
Level 1	256 8.000	242 7.563	229 7.156	727
Level 2	210 6.563	203 6.344	191 5.969	604
Level 3	179 5.594	168 5.250	163 5.094	510
Total	645 6.719	613 6.385	583 6.073	1841
		Totals: blocks 1, 2 and 3		
Level 1	696	673	689	2058
Level 2	608	588	607	1803
Level 3	482	451	493	1426
Total	1786	1712	1789	5287

$\sum_{a=1}\sum_{b=1}\sum_{c=1} X_{abc}^2 = 34,725$ $\sum (\sum X_{abc})^2 = 1,062,409$ $\sum_a (\sum_b \sum_c X_{abc})^2 = 9,337,397$

$\sum_b (\sum_a \sum_c X_{abc})^2 = 9,519,649$ $\sum_c (\sum_a \sum_b X_{abc})^2 = 9,321,261$ $T^2 = 27,952,369$

$\sum_a \sum_b (\sum_c X_{abc})^2 = 3,181,193$ $\sum_a \sum_c (\sum_b X_{abc})^2 = 3,117,675$ $\sum_b \sum_c (\sum_a X_{abc})^2 =$ 3,174,697

Applying the computation formulas, the calculations are as follows:

$$SS_T = \sum_{a=1}\sum_{b=1}\sum_{c=1} X_{abc}^2 - \frac{T^2}{mABC} = 34,725 - \frac{5287^2}{864} = 2372.7$$

$$SS_{cells} = \frac{\sum (\sum X_{abc})^2}{m} - \frac{T^2}{mABC} = \frac{1,062,409}{32} - 32,352.3 = 848.0$$

$$SS_w = SS_T - SS_{cells} = 2372.7 - 848.0 = 1524.7$$

Grouping:

$$SS_A = \frac{1}{mBC} \sum_a (\sum_b \sum_c X_{abc})^2 - \frac{T^2}{mABC} = \frac{9,337,397}{288} - \frac{5287^2}{864} = 69.2$$

Levels:

$$SS_B = \frac{1}{m\ AC} \sum_b (\sum_a \sum_c X_{abc})^2 - \frac{T^2}{mABC} = \frac{9,519,649}{288} - \frac{5287^2}{864} = 702.0$$

Subjects:

$$SS_C = \frac{1}{mAB} \sum_c (\sum_a \sum_b X_{abc})^2 - \frac{T^2}{mABC} = \frac{9,321,261}{288} - \frac{5287^2}{864} = 13.2$$

Interaction:

$$SS_{AB} = \frac{1}{mC} \sum_a \sum_b (\sum_c X_{abc})^2 - \frac{T^2}{mABC} - SS_A - SS_B = \frac{3,181,193}{96} - 32,352.3 - 69.2 - 702.0 = 13.9$$

$$SS_{AC} = \frac{1}{mB} \sum_a \sum_c (\sum_b X_{abc})^2 - \frac{T^2}{mABC} - SS_A - SS_C = \frac{3,117,675}{96} - 32,352.3 - 69.2 - 13.2 = 41.1$$

$$SS_{BC} = \frac{1}{mA} \sum \sum (\sum X_{abc})^2 - \frac{T^2}{mABC} - SS_B - SS_C = \frac{3,174,697}{96} - 32,352.3 - 702.0 - 13.2 = 2.2$$

$$SS_{ABC} = SS_{cells} - SS_A - SS_B - SS_C - SS_{AB} - SS_{AC} - SS_{BC} =$$

$$848 - 69.2 - 702.0 - 13.2 - 13.9 - 41.1 - 2.2 = 6.4$$

TABLE LI

COMPUTATION FOR ANALYSIS OF VARIANCE: 3 x 3 x 3 (RANDOM)

Rows - B Levels	Block 1 (Heterogeneous) - A Subjects (Columns) - C Language	Mathematics	Science	Total
Level 1	214	204	218	636
Level 2	190	177	188	555
Level 3	144	123	153	420
Total	548	504	559	1611
		Block 2 (Homogeneous)		
Level 1	242	245	247	734
Level 2	191	193	201	585
Level 3	165	163	172	500
Total	598	601	620	1819
		Block 3 (Subject Grouping)		
Level 1	248	237	219	704
Level 2	220	195	198	613
Level 3	170	162	158	490
Total	638	594	575	1807
		Totals: Block 1, 2 and 3		
Level 1	704	686	684	2074
Level 2	601	565	587	1753
Level 3	479	448	483	1410
Total	1784	1699	1754	5237

$\sum_{a=1}^{A}\sum_{b=1}^{B}\sum_{c=1}^{C} X_{abc}^2 = 34,395$ $\sum_{b}\sum_{a}\sum_{c} X_{abc})^2 = 1,045,461$ $\sum_{a}\sum_{b}\sum_{c} X_{abc})^2 = 9,169,331$

$\sum_{b}(\sum_{a}\sum_{c} X_{abc})^2 = 9,362,585$ $\sum_{c}(\sum_{a}\sum_{b} X_{abc})^2 = 9,145,773$ $T^2 = 27,426,169$

$\sum_{a}\sum_{b}(\sum_{c} X_{abc})^2 = 3,131,387$ $\sum_{a}\sum_{c}(\sum_{b} X_{abc})^2 = 3,060,511$ $\sum_{b}\sum_{c}(\sum_{a} X_{abc})^2 =$ 3,122,497.

Applying the computation formulas, the calculations are as follows:

$$SS_T = 34,395 - \frac{5237^2}{864} = 2651.7$$

$$SS_{cells} \frac{1,045,461}{32} - 31,743.3 = 927.4$$

$$SS_W = 2651.7 - 927.4 = 1724.3$$

Grouping:

$$SS_A = \frac{1611^2}{288} + \frac{1819^2}{288} + \frac{1807^2}{288} - 31,743.3 = 94.7$$

Levels:

$$SS_B = \frac{2074^2}{288} + \frac{1753^2}{288} + \frac{1410^2}{288} - 31,743.3 = 765.7$$

Subjects:

$$SS_C = \frac{1784^2}{288} + \frac{1699^2}{288} + \frac{1754^2}{288} - 31,743.3 = 12.9$$

Interaction:

$$SS_{AB} = \frac{3,131,387}{96} - 31,743.3 - 94.7 - 765.7 = 14.9$$

$$SS_{AC} = \frac{3,060,511}{96} - 31,743.3 - 94.7 - 12.9 = 29.4$$

$$SS_{BC} = \frac{3,122,497}{96} - 31,743.3 - 765.7 - 12.9 = 4.1$$

$$SS_{ABC} = 927.4 - 94.7 - 765.7 - 12.9 - 14.9 - 29.4 - 4.1 = 5.7$$

APPENDIX D

SUMMARY OF STANINE ACHIEVEMENT MEANS--TABLE LII

TABLE LII

SUMMARY OF STANINE ACHIEVEMENT MEANS

Levels	Method of Grouping		SUBJECTS Reading	Literature	Soc.Studies	Language	Mathematics	Science	$\bar{X}$
1	Hetero	A	7.281	7.563	6.938	6.531	6.344	7.000	6.943
		B	7.438	7.500	6.656	6.688	6.375	6.813	6.912
	Homo	A	7.438	7.750	7.719	7.219	7.125	7.375	7.438
		B	7.406	7.813	7.594	7.563	7.656	7.719	7.625
	3 Homo/	A	7.219	7.906	7.656	8.000	7.563	7.156	
	3 S.Gpg	B	7.844	7.656	7.469	7.750	7.406	6.844	
2	Hetero	A	6.313	6.438	6.281	6.063	5.813	6.219	6.188
		B	6.125	6.344	5.813	5.938	5.531	5.875	5.938
	Homo	A	6.656	6.469	6.469	6.375	6.219	6.781	6.495
		B	6.438	5.906	6.344	5.969	6.031	6.281	6.162
	3 Homo/	A	6.031	6.281	6.125	6.563	6.344	5.969	
	3 S.Gpg	B	6.188	6.750	6.344	6.875	6.094	6.188	
3	Hetero	A	4.969	5.125	4.813	4.688	3.906	5.000	4.750
		B	5.031	4.938	4.719	4.500	3.844	4.781	4.636
	Homo	A	5.063	4.563	5.250	4.783	4.938	5.313	4.984
		B	5.063	5.156	5.156	5.156	5.094	5.375	5.167
	3 Homo/	A	4.906	5.281	5.313	5.594	5.250	5.094	
	3 S.Gpg	B	5.063	4.875	5.281	5.313	5.063	4.938	
1,2,3	Hetero	A	6.188	6.375	6.010	5.760	5.354	6.073	5.960
		B	6.198	6.260	5.729	5.708	5.250	5.823	5.828
	Homo	A	6.385	6.260	6.479	6.125	6.094	6.490	6.306
		B	6.302	6.292	6.365	6.229	6.260	6.458	6.318
	3 Homo/	A	6.052	6.490	6.366	6.719	6.385	6.073	
	3 S.Gpg	B	6.365	6.427	6.365	6.646	6.188	5.990	

A: Matched Pairs Data; B: Random Data; 3 Homo: Reading, Literature, Social Studies.

B29828